Service Manual

CUB® AND CUB LO-BOY® TRACTORS

GSS-1411 W/Revision 1
February, 1976

INTERNATIONAL HARVESTER
AGRICULTURAL EQUIPMENT DIVISION
401 NORTH MICHIGAN AVENUE • CHICAGO, ILLINOIS, 60611, U.S.A.

Due to a continuous program of research and development, some procedures, specifications and parts may be altered in a constant effort to improve our products.

When changes and improvements are made in our products, periodic revisions may be made to this manual to keep it up-to-date. It is suggested that customers contact their dealer for information on the latest revision.

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NOTE: Refer to GSS-1052, Testing and Servicing Electrical Systems, for service information not contained in this manual.

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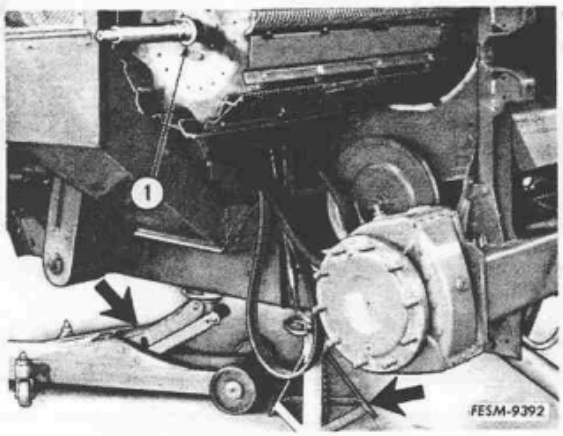
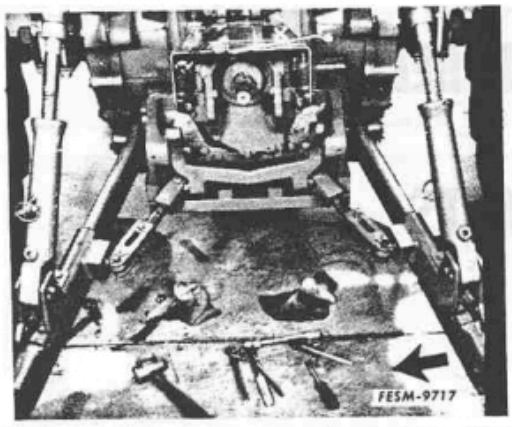
WORK SAFELY – FOLLOW THESE RULES

This symbol is used to call your attention to instructions concerning your personal safety. Be sure to observe and follow these instructions.

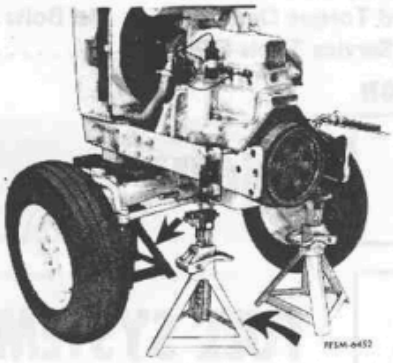


1. Always use safety stands in conjunction with hydraulic jacks or hoists. Do not rely on the jack or hoist to carry the load, they could fail.

2. Always wear safety glasses when using a hammer, chisel or other tools that may cause chips to fly.



3. Keep work area organized and clean. Wipe up oil or spills of any kind. Keep tools and parts off of the floor. Eliminate the possibility of a fall which could result in a serious injury.



4. When splitting tractors, or disassembling machines, be sure to use safety stands and adequate supports to prevent tipping or roll-over.

5. Use a safety catch on all hoist hooks. Do not take a chance, the load could slip off of the hook.

6. When using an acetylene torch always wear welding goggles and gloves. Keep a "charged" fire extinguisher within reach. Be sure the acetylene and oxygen tanks are separated by a metal shield and are chained to the cart. Do not weld or heat areas near fuel tanks or fuel lines and utilize proper shielding around hydraulic tanks or hydraulic lines.

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7. Always use a safety bar to block hydraulic cylinders. Never rely on the machine hydraulic system to hold when working on loaders etc. A hydraulic line or cylinder could fail or someone could accidently strike the control levers causing the loader to fall.

8. When reassembling subassemblies, parts, hoses, hydraulic lines, fuel lines, wiring etc., be sure they are positioned properly for alignment and clearance with related parts to their original setting and/or position.

9. Electrical storage batteries give off highly inflammable hydrogen gas when charging and and continue to do so for some time after receiving a steady charge. Do not under any circumstances allow an electric spark or an open flame near the battery. Do not lay tools across battery terminals as this may result in a spark or short circuit which may cause an explosion. Be careful to avoid spilling any electrolyte on hands or clothing.

10. Hydraulic fluid escaping under pressure can have enough force to penetrate the skin. Hydraulic fluid may also infect a minor cut or opening in the skin. If injured by escaping fluid, see a doctor at once. Serious infection or reaction can result if medical treatment is not given immediately.

Do not attempt to repair or tighten hoses that are under pressure, when the boom is raised, or with the tractor engine running. Cycle all hydraulic control valves to relieve all pressure before disconnecting the lines or performing other work on the hydraulic system. Make sure all connections are tight and hoses and lines are in good condition before applying pressure to the system. To locate a leak under pressure, use a small piece of cardboard or wood. Never use hands.

11. When refueling, keep the hose and nozzle or the funnel and container in contact with the metal of the fuel tank to avoid the possibility of an electric spark igniting the fuel. Do not overfill the fuel tank – overflow creates fire hazard. Do not smoke when refueling. Never refuel when engine is hot or running.

12. Always use a protective fixture when inflating tubeless tires that have been repaired or are loose on the rim. Do not inflate over 30 psi to seat the tire bead.

13. Use pullers to remove bearings, bushings, gears, cylinder sleeves etc. when applicable. Use hammers, punches and chisels only when absolutely necessary. Then, be sure to wear safety glasses.

14. Never use trouble lights or electric powered tools that have cut and/or damaged cords or plugs. Be sure all electric tools are properly grounded.

15. Be careful when using compressed air to dry parts. Use approved air blow guns, do not exceed 30 psi, wear safety glasses or goggles and use proper shielding to protect everyone in the work area.

16. Do not wear rings, wrist watches or loose fitting clothing when working on machinery, they could catch on moving parts causing serious injury.

17. Excessive or repeated skin contact with sealants or solvents may cause skin irritation. In case of skin contact, remove sealant or solvent promptly by washing with soap and water.

IMPORTANT: The above is only a partial list of safe work rules. In addition, always refer to the Operator's Manual for the specific machine for additional safe work rules regarding the machine operation.

STANDARD TORQUE DATA FOR NUTS AND BOLTS— FOOT POUNDS

Recommended torque for all Standard Application Nuts and Bolts, provided:

A. All thread surfaces are clean and lubricated with SAE-30 engine oil. (See NOTE.)

B. Joints are rigid, that is, no gaskets or compressible materials are used.

C. When reusing nuts or bolts use minimum torque values.

NOTE: Multiply the standard torque by:
- .65 when finished jam nuts are used.
- .70 when Molykote, white lead or similar mixtures are used as lubricants.
- .75 when parkerized bolts or nuts are used.
- .85 when cadmium plated bolts or nuts and zinc bolts w/waxed zinc nuts are used.
- .90 when hardened surfaces are used under the nut or bolt head.

1 FOOT POUND = 1.355 NEWTON METERS

Bolt or Stud Diameter		Type 1 Studs Only		Type 1 Bolts 6" length or less		Type 1 Bolts longer than 6"		Type 5 (all lengths)		Type 8 (all lengths)			
										Only when used† in cast (gray) iron		All other applications	
Inches	MM	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
1/4	6.4	5	6	5	6	3	3	9	10	11	13	12	14
5/16	8.0	12	13	12	13	6	7	19	21	24	27	27	30
3/8	9.5	21	24	21	24	11	13	33	37	43	47	45	50
7/16	11.1	35	38	35	38	19	21	53	60	69	76	75	85
1/2	12.7	52	58	52	58	29	32	80	90	104	117	115	130
9/16	14.3	70	80	70	80	41	46	115	130	150	170	165	185
5/8	15.9	98	110	98	110	57	63	160	180	210	230	220	250
3/4	19.0	174	195	174	195	100	112	290	320	350	390	400	450
7/8	22.2	300	330	162	181	162	181	420	470	570	630	650	730
1	25.4	420	470	250	270	250	270	630	710	850	950	970	1090
1-1/8	28.6	600	660	350	380	350	380	850	950	1200	1350	1380	1550
1-1/4	31.8	840	940	490	540	490	540	1200	1350	1700	1900	1940	2180
1-3/8	34.9	1100	1230	640	710	640	710	1570	1760	2300	2500	2600	2800
1-1/2	38.1	1470	1640	850	940	850	940	2000	2300	3000	3300	3300	3700
1-3/4	44.5	2350	2450	1330	1490	1330	1490	3300	3700	4700	5200	5300	6000
2	50.8	3500	3900	2000	2200	2000	2200	5000	5500	7000	7800	8000	9000

†When bolt penetration is 1-1/2 times the diameter of the bolt.

BOLT TYPE IDENTIFICATION CHART

IH TYPE	S.A.E. GRADE	DESCRIPTION	BOLT HEAD MARKING *
1	Equivalent 1 or 2	WILL HAVE A IH STANDARD MONOGRAM IN THE CENTER OF THE HEAD Low or Medium Carbon Steel Not Heat Treated	
5	5	WILL HAVE A IH AND 3 RADIAL LINES Quenched and Tempered Medium Carbon Steel	
8	8	WILL HAVE A IH AND 6 RADIAL LINES Quenched and Tempered Special Carbon or Alloy Steel	

*The center marking identifies the bolt manufacturer. The IH monogram is currently used. Some bolts may still have an IH or a raised dot which previously identified IH bolts.

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SPECIAL SERVICE TOOLS REQUIRED

SECTION 1

FES 33-1	Fan drive pulley remover
FES 33-4	Fan drive pulley wear sleeve installer
FES 100	Engine lifting chain assembly
FES 108	Piston fitting set
FES 138	Lifting sling
FES 142-1	Engine stands

SECTION 2

FES 36-3	
FES 36-4	Special plier

SECTION 5

FES 50	Clutch service tool

SECTION 8

FES 1-2	Hydraulic pressure gauge
FES 94-6	Pressure snubber

Order from: Service Tools
P. O. Box 314
Owatonna, MN 55060

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ENGINE

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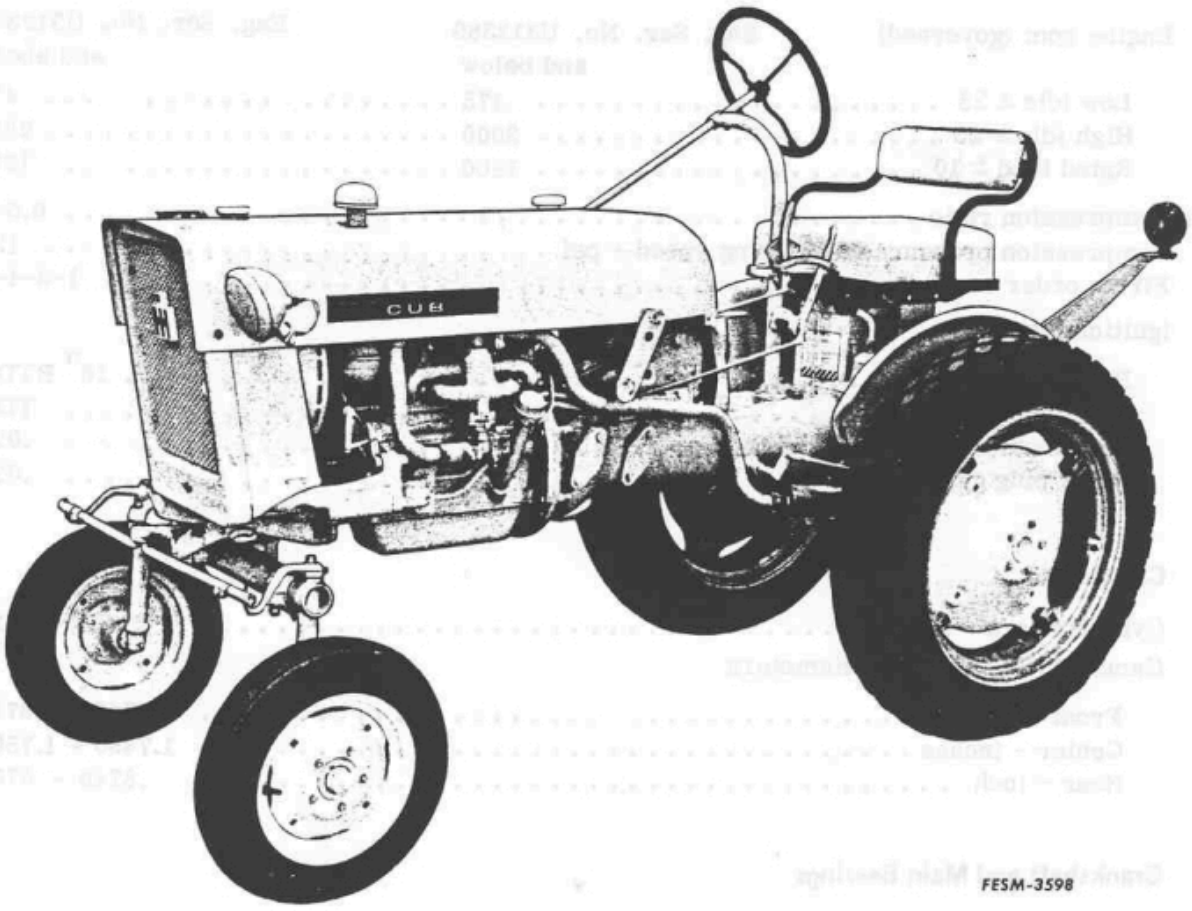


FESM-3598

SPECIFICATIONS

General

Model	C-60
Number of cylinders	4
Bore and stroke - inches	2-5/8 x 2-3/4
Displacement - cubic inches	59.5

Engine rpm (governed)	Eng. Ser. No. U312389 and below	Eng. Ser. No. U312390 and above
Low idle ± 25	475	475
High idle ± 25	2000	2080
Rated load ± 10	1800	1900

Compression ratio	6.5-1
Compression pressure at cranking speed - psi	120
Firing order	1-3-4-2

Ignition timing

High idle	16° BTDC
375 rpm or below	TDC
Distributor point gap - inch	.020
Spark plug gap - inch	.023

Crankcase

Cylinder bore - inches	2.625 - 2.627

Camshaft bearing bore diameters

Front - inches	1.8740 - 1.8755
Center - inches	1.7490 - 1.7505
Rear - inch	.8740 - .8755

Crankshaft and Main Bearings

Crankshaft

Type	Counter balanced
Number of main journals	3
Main journal diameter - inches	1.623 - 1.624
Crankpin diameter - inches	1.498 - 1.499

Main Bearings

Type	Tri-metal, precision
Running clearance - inch	.002 - .003
Thrust bearing location	Center
Thrust bearing side clearance - inch	.004 - .008

Bearing OD and spread

Front and rear - inches	1.777 + .020
Center - inches	1.777 + .002 to .015

Camshaft

Drive	Helical gear
Cam lobe lift (total) - inch	.232 ± .002

Diameter at bearing areas

Front - inches	1.871 - 1.872
Center - inches	1.746 - 1.747
Rear - inch	.872 - .873

Thrust taken by	Thrust plate
Number of bearings	3 (bored in crankcase)

Bearing running clearance

Front and center - inch	.002 - .0045
Rear - inch	.001 - .0035

End clearance - inch	.003 - .012

Connecting Rods

Type	I-Beam
Side clearance - inch	.005 - .012
Bearing running clearance - inch	.002 - .003

Bearing type

Upper end	Bronze bushing
Lower end	Tri-metal, precision

Bearing OD and spread - inches	1.625 + .025
Piston pin bushing (installed and bored) ID - inch	.6879 - .6882

Pistons

Type	Full skirt
Material	Grey iron
Overall length - inches	2.875
Diameter - inches	2.6230 - 2.6234
*Skirt clearance, bottom - inch	.0016 - .0024 (measured at 90° from pin hole)
Number of rings per piston	3
Piston pin hole bore - inch	.6877 - .6880

*See "Piston Fit in Bore", page 1-31.

Pistons — Continued

Width of ring groove - inch	
Top compression	.0955 - .0965
Second compression	.0955 - .0965
Oil control	.1880 - .1890
Ring clearance in groove - inch	
Top compression	.0020 - .0035
Second compression	.0020 - .0040
Oil control	.0015 - .0030

Piston Pins

Type	Full floating
Diameter - inch	.6875 - .6876
Length - inches	2.185 - 2.195
Clearance between end of pin and retainer ring - inch	.010 - .030
Clearance in rod bushing - inch	.0003 - .0007
Clearance in piston - inch	.0001 - .0005

Piston Rings

Compression	
Number per piston	2
Type	
Top	Chrome
Second	Plain
Width of ring	
Top - inch	.0930 - .0935
Second - inch	.0925 - .0935
End gap	
Top - inch	.007 - .017
Second - inch	.007 - .017
Oil Control	
Type	Chrome, wide slot
Number per piston	1
Width - inch	.1860 - .1865
End gap - inch	.007 - .020

Valves

Head diameter	
Intake - inches	1.089 - 1.099
Exhaust - inch	.901 - .911
Face angle - degrees	45-1/2
Stem diameter	
Intake - inch	.3095 - .3105
Exhaust - inch	.3095 - .3105
Clearance in guide	
Intake - inch	.001 - .003
Exhaust - inch	.0015 - .0035

Valve Seats

Seat angle - degrees	45
Seat width	
Intake - inch	3/64
Exhaust - inch	3/64

Valve Guides

Length - inches	1.34
Inside diameter	
Intake - inch	.3115 - .3125
Exhaust - inch	.3120 - .3130
Installed height below crankcase surface - inches	1-3/32

Valve Springs

Free length	
Intake - inches	1-31/32
Exhaust w/o rotocap - inches	1-31/32
Exhaust w/rotocap - inches	1-7/16
Test length	
Intake - inches	1-1/4
Exhaust w/o rotocap - inches	1-1/4
Exhaust w/rotocap - inches	1-3/16

Valve Springs — Continued

Test load
- Intake - pounds 23
- Exhaust w/o rotocap - pounds 23
- Exhaust w/rotocap - pounds . . . . . 14 - 16

Valve Tappets

Diameter - inch . . . . . .591 - .592
Length - inches . . . . . 2.370 - 2.380
Clearance in crankcase - inch . . . . . .0007 - .0032
Valve lash (engine cold) - inch 015

Valve Timing

Intake opens - degrees . . . . . 10 before TDC
Intake closes - degrees . . . . . 45 after BDC
Exhaust opens - degrees . . . . . 45 before BDC
Exhaust closes - degrees . . . . . 5 after TDC

Cylinder Head

Bolt diameter - inch 3/8
Torque - ft. lbs. 45

Timing Gears

Crankshaft pinion . . . . . 18 teeth
Camshaft gear . . . . . 36 teeth
Idler gear . . . . . 36 teeth
Governor-ignition gear . . . . . 18 teeth
Type of teeth . . . . . Helical
Backlash - inch . . . . . .003 - .006
Idler shaft retainer bolt tension - ft. lbs. 90

Lubrication System

Oil pressure at 1800 rpm - psi . . . . . 30 - 35

Oil pump
- Type . . . . . Gear
- Drive . . . . . Direct from camshaft
- Gear backlash - inch . . . . . .003 - .006

Number of teeth
- Idler gear 13
- Drive gear 13

Lubrication System — Continued

Oil pressure valve regulating spring

Free length - inches	2-31/32
Test length - inches	2-15/32
Test load - pounds	9-1/2

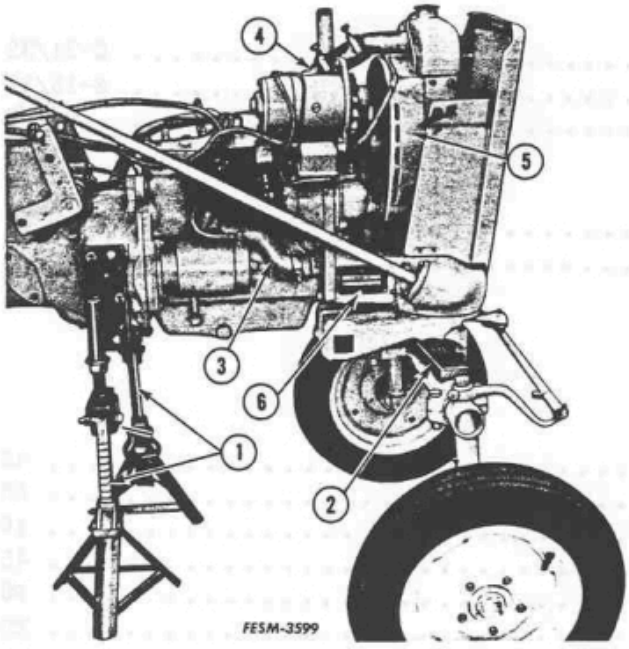
Pressure regulating valve

Valve diameter - inch	.6205 - .6215
Location	In crankcase

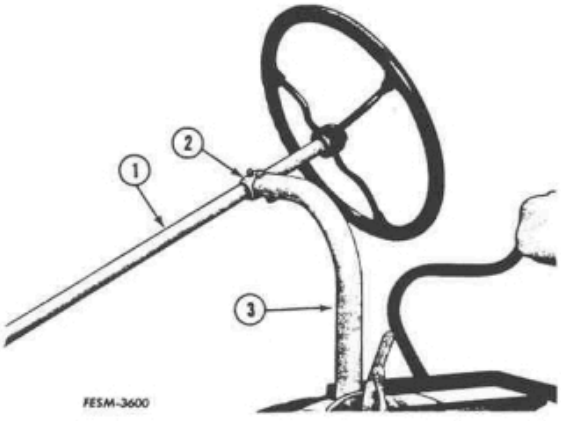
Special Torques (foot pounds)

Cylinder head	45
Main bearing	55
Connecting rod	16
Flywheel	45
Idler gear retainer bolt	90
Manifold	20
Spark plugs	30

ENGINE REMOVAL



1. Support stands, FES 142-1
2. Wooden wedges
3. Inlet elbow
4. Outlet elbow
5. Fan housing
6. Steering gear housing



1. Steering shaft
2. Steering shaft support bracket
3. Steering shaft support arm

1. Disconnect the ground cable from the battery, and the wires from the headlights.

2. Remove the headlights. Shut off fuel at the fuel strainer and disconnect the fuel line. Remove the hood and fuel tank assembly.

3. Block the front axle on both sides with wooden wedges (2). Support the rear of the tractor with the support stands, FES 142-1.

4. Remove the pipe plug located in the bottom of the steering gear housing assembly (6) and drain the coolant.

5. Disconnect and remove the water inlet (3) and outlet elbows (4).

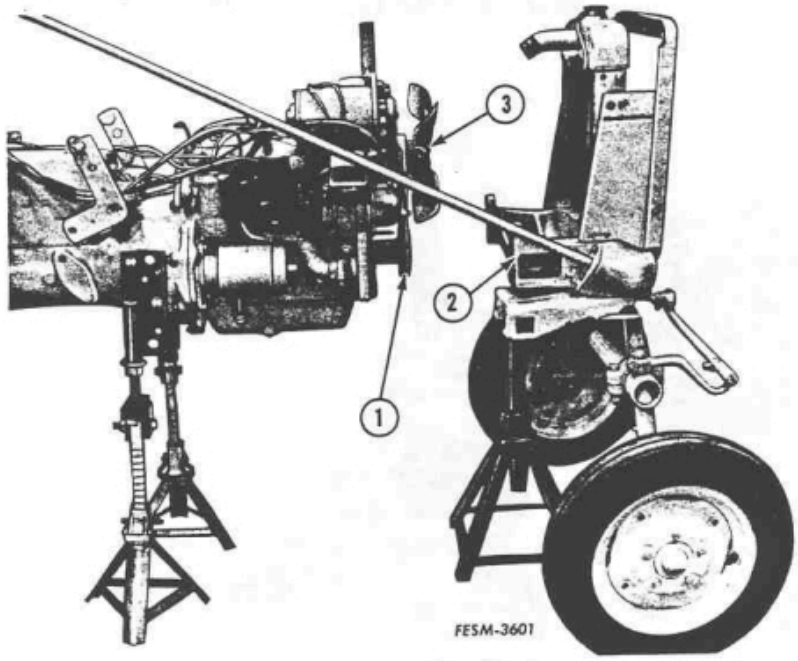
6. Remove the water inlet nipple from the R. H. side of the steering gear housing.

7. Remove the screws securing the cooling fan housing (5) to the radiator.

8. Disconnect the steering shaft bracket (2) from the steering support arm (3).

NOTE: The front axle and radiator assembly must be supported by a stand or jack to prevent it from tipping backward.

9. Remove the two bolts and two cap screws between the engine and steering gear housing.

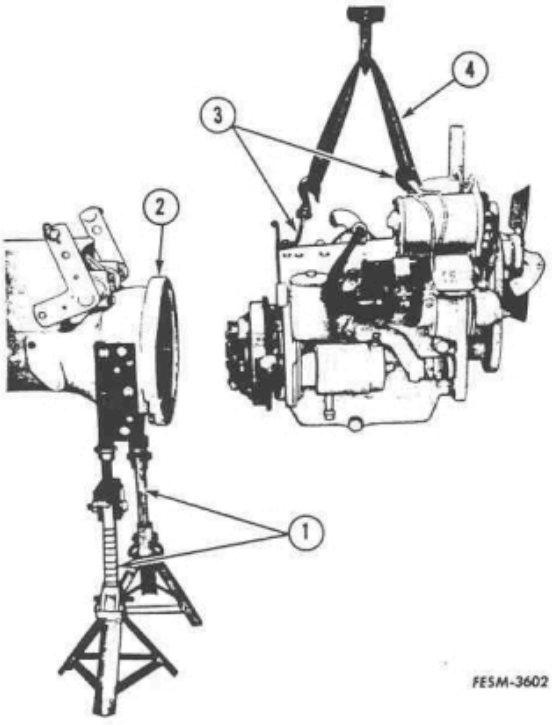


1. Fan drive pulley
2. Steering gear housing
3. Cooling fan assembly

10. Raise the engine so the fan drive pulley (1) clears the steering gear housing (2) and roll the front axle away from the engine.

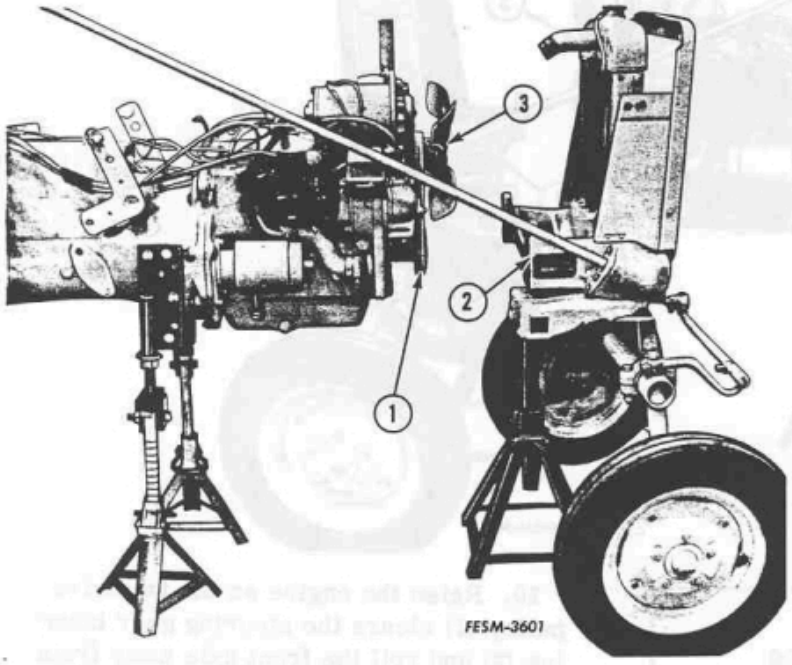
11. Attach the lifting brackets (3) FES 100, to the engine and support it with a sling (4), FES 138, and a hoist.

12. Perform a front section split to remove the engine from the clutch housing (2). (Refer to "Front Section split", Section 4.)



1. Support stands, FES 142-1
2. Clutch housing
3. Lifting brackets, FES 100
4. Sling, FES 138

ENGINE INSTALLATION



1. Fan drive pulley
2. Steering gear housing
3. Cooling fan assembly

1. If the clutch assembly was removed from the engine, use a pilot shaft to center the clutch driven disc. (Refer to clutch "Installation", Section 5.)

2. Support the engine using the lifting brackets, lifting sling and a hoist, and position the engine on the clutch housing.

3. Install the two cap screws and the nuts and bolts in the engine and clutch housing. Tighten to 55 and 35 ft. lbs. torque respectively.

4. Install the clutch housing cover and secure with the nuts and bolts. Install the clutch housing hand hole cover if it was removed.

5. Connect the wiring harness wires to the coil, ground, regulator and lights. Connect the wire to the starter.

6. Using a new gasket and O-rings, install the hydraulic manifold tubes to the pump and the cylinder block assembly.

7. Install the governor control rod.

8. Install the choke control rod.

9. Install the exhaust pipe.

10. Position the steering gear housing assembly (2) on the front of the engine.

11. Install the cooling fan housing on the radiator.

12. Install the cap screws and bolts securing the steering gear housing to the engine.

13. Connect the steering shaft bracket to the steering shaft support arm.

14. Install the water inlet nipple in the steering gear housing.

15. Install and connect the water inlet and outlet elbows and hoses.

16. Install the pipe plug in the steering gear housing and fill the radiator with the recommended coolant. (Refer to Operator's Manual.)

17. Install the hood and fuel tank assembly. Connect the fuel line to the fuel strainer.

18. Connect the wires to the lights and the ground wire to the battery.

CYLINDER HEAD

Removal

1. Remove the pipe plug in the bottom of the steering gear housing and drain the coolant.

2. Disconnect and remove the headlights.

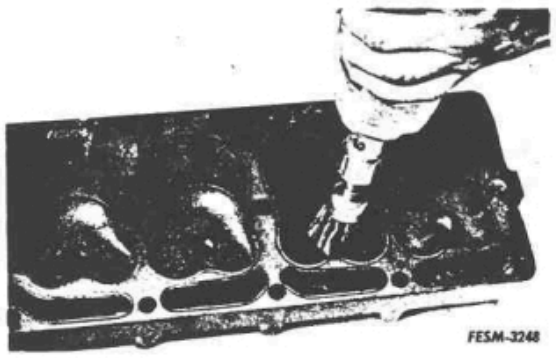
3. Disconnect the fuel line from the fuel strainer. Remove the hood and fuel tank from the tractor.

4. Remove the water outlet elbow and hose.

5. Remove the spark plugs.

6. Remove the cylinder head cap screws, and remove the cylinder head and gasket from the engine.

Inspection and Repair


FESM-3248

1. Check the head and gasket for "blow-by" or compression leaks.

2. Remove carbon from combustion chamber cavities with a wire brush.

3. Clean cylinder head combustion cavities with cleaning solution.

4. Carefully inspect head for cracks.

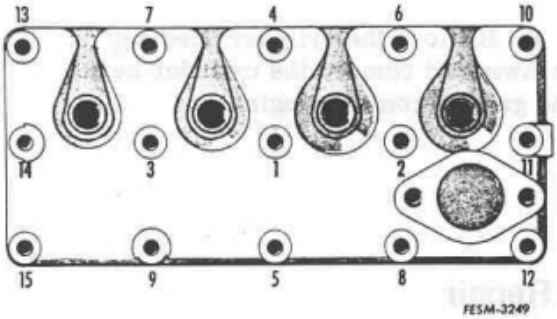
5. Use a straight edge and inspect for warped head, particularly in any area which shows "blow-by."

6. Inspect water jacket in head for an accumulation of rust or lime deposit which would affect circulation of cooling water and cause hot spots. Clean if necessary.

7. Thoroughly clean the gasket surface to insure proper sealing of the new gasket.

8. Be sure to use a new gasket.

Installation



1. Using a new gasket, install the cylinder head on the engine.

2. Install the cylinder head cap screws. Using the sequence shown, tighten evenly in steps to 45 ft. lbs. torque. Be sure to install all brackets and mounting clips under the cap screw heads before tightening.

3. Install the spark plugs and tighten to 30 ft. lbs. torque.

4. Install the water outlet elbow and hose.

5. Install the hood and fuel tank and connect the fuel line.

6. Install the headlights and connect the wires.

7. Refill the radiator with coolant.

VALVES

Valve Lash Adjusting Procedure

Following the simplified procedure in the chart below, all valves can be adjusted accurately. Note that the engine does not need to be cranked four times to position the piston of each cylinder on T.D.C. All valves are adjusted by cranking the engine only twice.

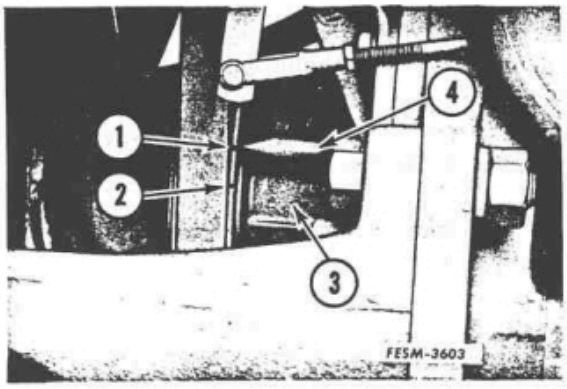
Four valves are adjusted when the No. 1 piston is at T.D.C. (compression) and the remaining four are adjusted when the No. 4 piston is at T.D.C. (compression).

WITH	ADJUST VALVES (Engine Cold)							
No. 1 Piston at T.D.C. (Compression)	1	2	3		5			
No. 4 Piston at T.D.C. (Compression)				4		6	7	8

1. Remove the intake and exhaust manifold assembly. Remove the valve tappet cover. Clean the gasket mating areas to insure proper sealing when re-assembled.

2. Check the entire valve assembly for rust and dirt. Inspect for looseness in the valve assembly and for worn or broken valve springs.

3. Remove the spark plugs from No. 1 cylinder (nearest the radiator) and No. 4 cylinder.

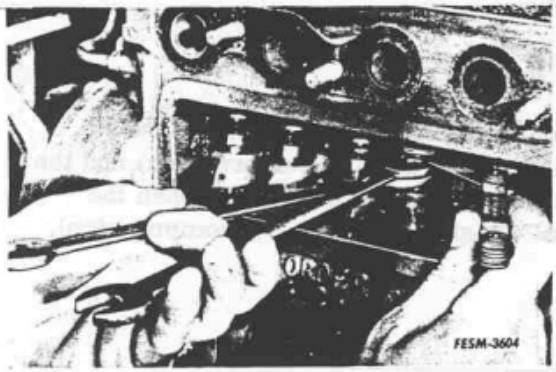


1. T.D.C. mark
2. 16° mark (B.T.D.C.)
3. Fan drive pulley
4. Timing pointer

4. Place a thumb over the No. 1 spark plug opening and slowly hand crank the engine until an outward pressure can be felt. Pressure indicates the piston is moving toward top dead center of the compression stroke.

5. Continue cranking slowly until the T.D.C. mark (1) on the fan drive pulley (3) is in line with the timing pointer (4) on the crankcase front cover.

NOTE: Valve tappets have self-locking tappet screws. Adjustment requires two wrenches, one to hold the tappet and one to turn the tappet screw.



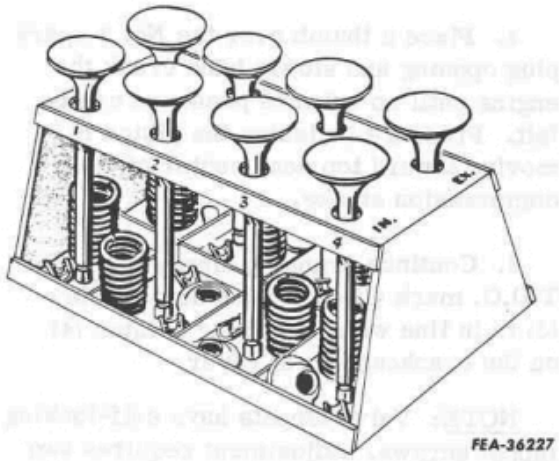
6. Insert the feeler gauge between the valve tappet and the valve stem. The specified clearance is .015 inch (engine cold). Turn the adjusting screw in or out as necessary to give a slight drag on the feeler gauge. Adjust the four valves specified in the chart on page 1-15.

7. Crank the engine until the No. 4 piston is on T.D.C. (compression) and the T.D.C. mark (1) on the fan drive pulley is in line with the timing pointer (4). (Refer to illustration on page 1-15.) Adjust the remaining four valves.

8. Install the valve cover being sure to use a new gasket. Check for any oil leaks.

9. Install the intake manifold with a new gasket.

Removing Valves

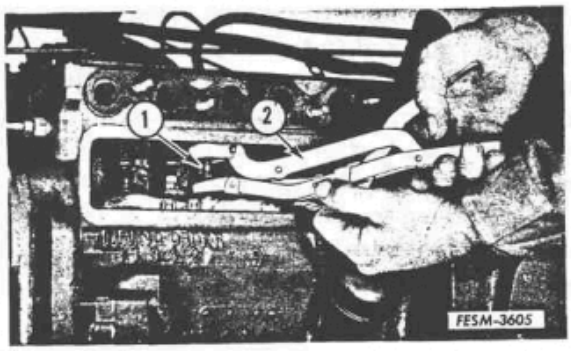


NOTE: When valve assemblies are removed, all parts should be kept in order. They may then be reinstalled in the same ports, from which removed, if they are to be used for further service.

1. Drain the cooling system and remove the cylinder head.

2. Remove the intake and exhaust manifold assembly.

3. Remove the valve tappet cover, and turn down the tappet screws several turns so the springs may be removed easily and to prevent interference with valve stems after seats and faces are reground.



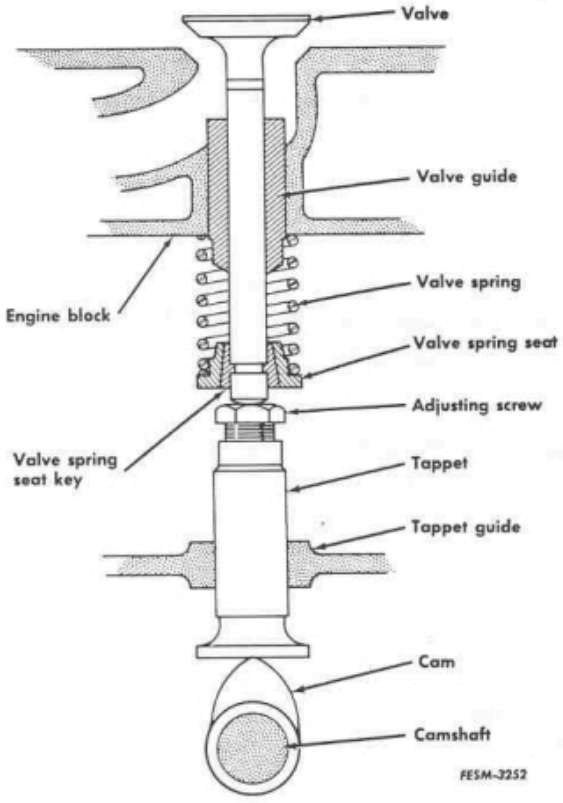
1. Valve spring seat keys
2. Valve spring compressor

4. Compress the valve springs with a valve spring compressor (2) and remove the valve spring seat keys (1). Be careful not to compress the springs more than necessary as they can be distorted.

5. Remove the valves, valve spring seats and valve springs. Be sure to keep valves in order so they may be installed in the same port.

NOTE: To remove the tappets the camshaft must be removed.

Inspection



General

Carbon deposits on the valves and valve seats are normal and cannot be avoided completely. However, such deposits are detrimental to engine efficiency and valve assembly life as the amount of carbon in the engine increases.

The rotating mechanism (if equipped) used on the exhaust valves greatly extends the service life of the valves.

Valves and valve seats should be examined for pitting, burning, warping and other defects.

The formation of carbon cannot be avoided. However, it can be held to a minimum by the use of only good grade fuels and accurate engine timing.

Warpage, burning and pitting of valves is mainly directed against the exhaust valves which are exposed to the high temperature flow of exhaust gases. Such defects are generally caused by valves failing to seat tightly and evenly, permitting exhaust blow-by. This, in turn, can generally be traced to hard particles of carbon being present on the slopes of the valve seats. It may, however, be due to weak springs, insufficient valve clearance, or warpage and misalignment of the valve stem or guide.

Warpage, chiefly occurs on the valve stem due to its exposure to heat. Out-of-round wear occurs when the seat has been pounded by a valve head which is not in line with its stem or guide.

Misalignment is a result of wear, warpage, and distortion. Wear, when accentuated by insufficient lubrication, will eventually create sloppy clearances with resultant misalignment.

Warpage of the valves, and in known extreme instances, that of the crankcase, can result from the engine overheating due to a blocked, dirty or insufficiently filled cooling system.

Most frequently, however, warpage of a valve stem or a guide is due to uneven temperatures being applied along its length. The lower part of the guide and stem is near the combustion heat, and the upper portions are closer to cylinder head water passages. Valve materials are carefully chosen to withstand such varying temperatures. However, an engine that is allowed to operate continually in an overheated condition is definitely open to valve stem and guide distortion and warpage. Distortion can also be caused by failure to tighten cylinder head bolts to the specified foot-pounds torque and in the sequence recommended. Valve clearances are also affected in this manner. Thus any abnormal wear, warpage or distortion affecting a valve guide will destroy its function as an accurate bearing to maintain the valve head concentric with its seat, and will prevent leak-proof seating.

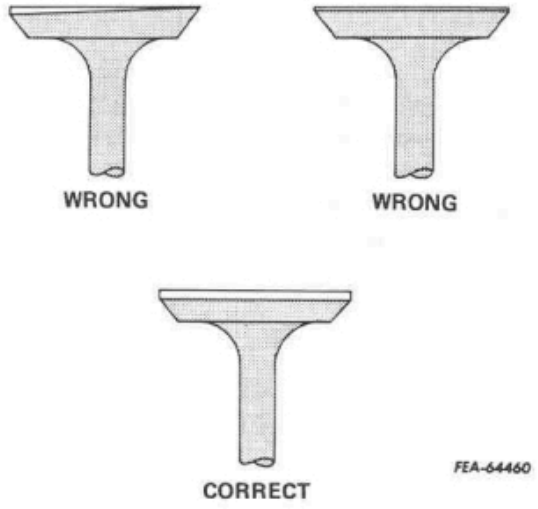
Oil and air sucked past worn intake valve stems and guides into the combustion chamber, cause excessive oil consumption, form excessive carbon, and dilute fuel.

Examine the engine for signs which may indicate the reason for the need of valve reconditioning. Dry and rusted valve springs are an indication that the oil passages to the valve levers may be blocked, causing wear on the valves and guides, and resulting in improper valve action. A defective gasket under the valve cover will permit the entrance of dirt which will cause undue wear on the valve stems and guides and damage to the valve springs.

Valves

1. Remove all carbon from the valve head and stem. Valve stems should be lightly polished with an extremely fine abrasive cloth sufficiently to remove the carbon deposits only. Because of the nature of the valve deposits, solvent cleaning ordinarily will not remove all the deposits from the valves. Wire brushes will do this job satisfactorily, but only brass wire brushes should be used since steel brushes may scratch the surface. Such scratches are likely to cause localized stresses in an operating valve and may eventually result in fatigue fractures of the valve. For similar reasons the use of coarse emery paper should be avoided.

2. Inspect each valve. See that the stem is not worn excessively and that the head is not burned or warped. Check the grooves in the stem to see that they have not lost the shoulders through wear, which prevents the valve seat retainer keys from fitting snugly.



3. All valves having bent, worn, warped or seriously pitted stems should be replaced. Replace any valve that cannot be satisfactorily refaced with a definite margin maintained. The amount of grinding necessary to true the valve face is a definite indication of the valve head warpage from the axis or centerline of its stem. With excessive warpage, a knife edge will be ground on part or all of the valve head due to the considerable amount of metal that must be removed to completely reface. Maximum heaviness in a valve head is required for strength and to provide as large an area as possible for heat dissipation. Knife edge valves lead to breakage and warpage.

4. Clean and examine all valve springs for rust, pitting, broken or set coils. Test each spring against the spring specifications (see "Specifications") using a spring load tester. Replace all springs that do not meet specifications.

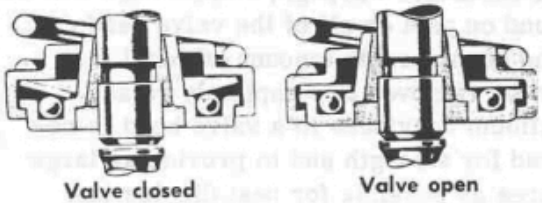
5. Clean all valve spring seats with solvent, and examine them for rust, cracks and bending characteristics. Replace parts as necessary.

Valve Seat Retainer Keys

Clean parts thoroughly in solvent. Check the ribs in the inside of the keys to see that none are worn sufficiently to cause looseness. The keys must fit snugly into the valve stem groove. Check the keys for wear on the outside surface which might allow the valve spring retainer to slide over the key.

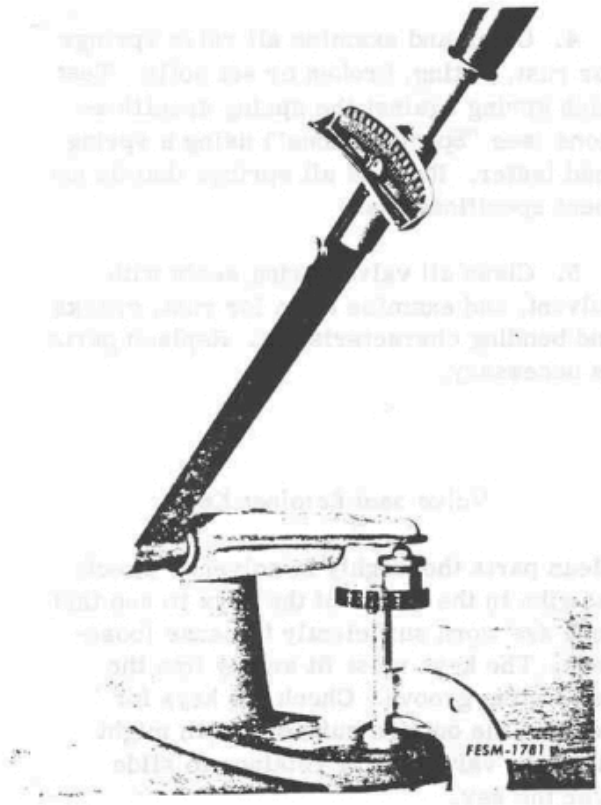
Valve Guides

Clean the bores of the valve guides, using a wire rifle brush and solvent. Blow out all carbon with compressed air. Position a light at the bottom of the guide bore, and examine the walls for burning, cracking and signs of excessive wear. Check the inside diameter of the guide bore at several points around its circumference and along its length. Replace any guides considered unserviceable or that appear close to a serviceable borderline.



Valve closed Valve open

FESM-1779



FESM-1781

NOTE: All valve reconditioning equipment requires the installation of a pilot in the valve guide to produce a seat concentric with the guide bore. For this reason the guides must be clean and meet the engine specifications before the valve seats can be reconditioned.

Valve Seats

Remove all carbon and any remaining gasket material from the crankcase surface. Inspect all valve seats for cracks. Remove the carbon from the valve seat recesses or counterbores.

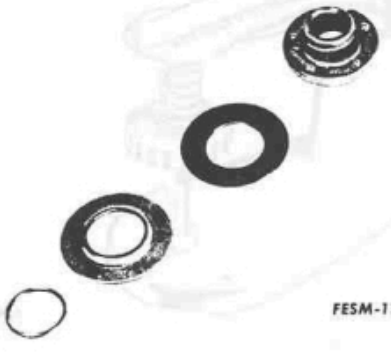
Rotocap

When the Rotocap is in operation, the valve spring is compressed (valve opened), the bellville washer is brought to bear on the steel balls. This causes the balls to roll down the ramp in the retainer thus rotating the valve.

Testing Rotators

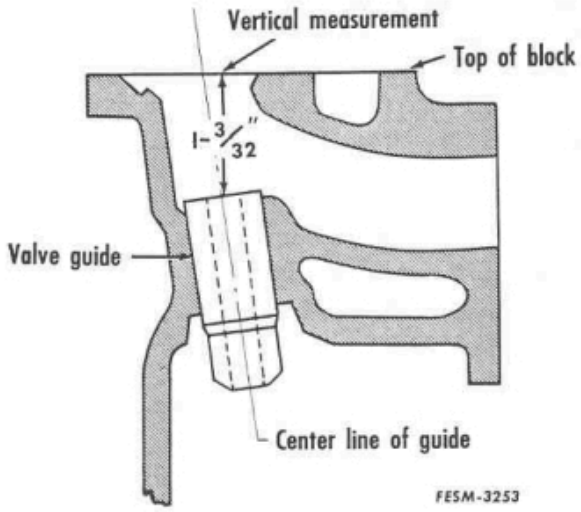
Use any valve spring tester and a steel ball placed on an inner sleeve, then rapidly oscillate the load.

You should perform this oscillation up to the test load indicated in "Specifications". Be sure the rotator is lubricated internally. The rotators should be cleaned, checked and reinstalled at each overhaul period.



FESM-1778

Observing the operation of the valves prior to tear-down of the engine is beneficial in preventing unnecessary checking of worn rotators. Mark the valves with a pencil as movement is relatively slight.



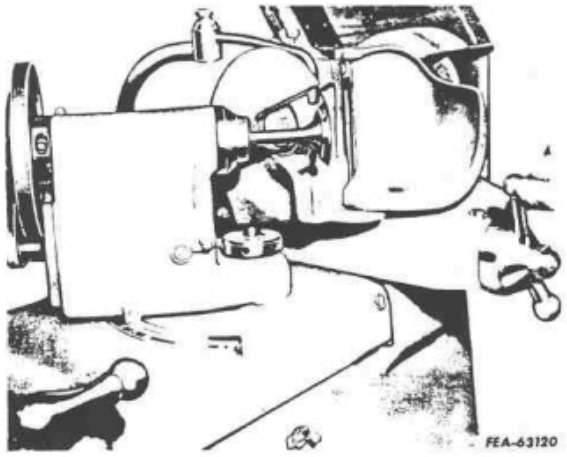
Reconditioning

Valve Guides

1. Press the guides from the crankcase.

2. Install new guides from the top of the crankcase, and press them into the crankcase bores to a measured distance of 1-3/32 inch from the top surface of the block to the top center of the guide.

3. All guides furnished as service parts are reamed to size; however, as they are a press fit, it is necessary to burnish them after installation to remove any possible burrs or slight distortion caused by the pressing operation.



Valves

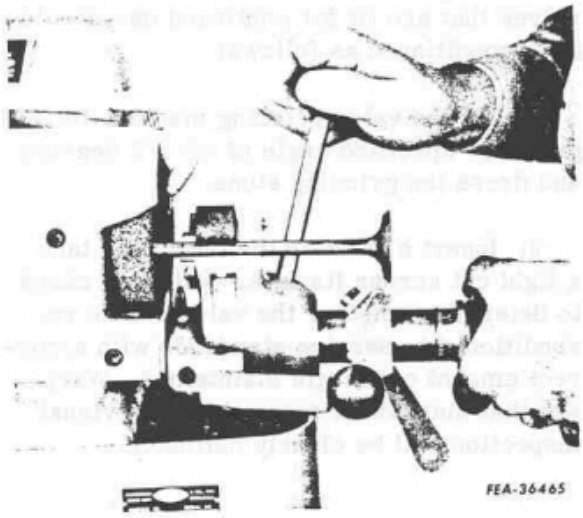
After being thoroughly cleaned and inspected, valves that are fit for continued use should be reconditioned as follows:

1. Set the valve refacing machine to grind the specified angle of 45-1/2 degrees and dress the grinding stone.

2. Insert a valve in the chuck and take a light cut across its face. This is a check to determine whether the valve can be reconditioned to service standards with a correct amount of margin maintained. Warpage that may not be apparent in the visual inspection will be clearly definable.

Avoid taking heavy grinding cuts as this heats the valve head excessively, producing an unsatisfactory valve face, and necessitates dressing the grinding wheel frequently. Repeated light grinding cuts are preferred until a true face of even width is obtained around the valve. Avoid passing the stone beyond the face of the valve as this will cause ridging and grooving of the stone surface and make dressing of the stone necessary. Reject all valves with distorted heads which produce an uneven face and valves which grind down to a thin edge.

One of the principal difficulties in reconditioning valves is to obtain nearly identical angles on the valve seat and valve face. The importance of these angles in the grinding operation cannot be overemphasized, because it is impossible to produce a flat or square seat by lapping.



The grinding stones on both the valve refacing machine and valve seat grinder should be dressed before starting a reconditioning job.

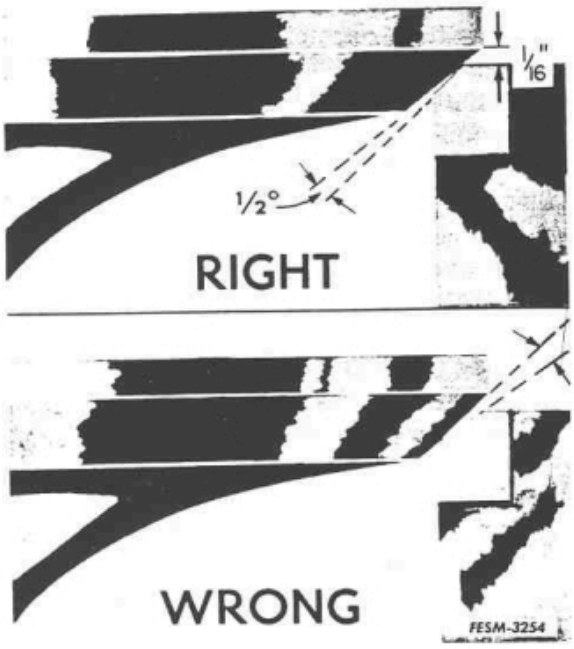
You will be unable to determine how closely the angle of the seat will match the valve face until the valve and seat have been ground and a check made with a very light tint of Prussian blue. If a full seat-width contact around the entire circle of seated valve is not shown, the angles do not match. It will then be necessary to redress the valve seat grinding stones, changing the angle sufficiently to correct the error. The correction should be made on the valve seat, and not on the valve. No more material should be removed from the valve face than is necessary to true it up and remove the burned or pitted portion. New valves should not be refaced, but should be checked for trueness. When a satisfactory match of valve seat and valve face angles has been obtained, the adjustment of both the valve refacer and the seat grinder should be locked in position, in order to eliminate this trial-by-error method on additional valves having the same angle.

At times unusually large amounts of heat scale may be found on exhaust valves, which is hard on the grinding stone. Frequent redressing of the stone will be necessary to maintain a smooth even surface and a uniform set of valve face angles.

After refacing each valve, inspect the end of the stem. If wear is noticeable, reface the end of the stem. Grind sufficiently to true-up the end of the stem.

Perhaps it has been noticed that on many International Harvester Farm Equipment engines, the valve face and seat are ground to an "interference angle". This means that the sum of the seat angle and the face angle do not equal 90 degrees.

This is done to avoid the possibility of grinding a reverse interference angle, and to help prevent the accumulation of combustion deposits on valve faces and seats. It is nearly impossible for anyone to grind perfectly matching angles.



Grinding of valves to an interference angle provides line contact of the valve face to the seat for the first few hours of operation, allowing the valve and seat to "wear in" to a good tight contact. Interference angle has the effect of increasing the pressure per square inch on the seat, thus causing any deposits which cling to the face or seat to be squeezed out of the way and eventually blown out.

Valve Seats

The primary purpose of a valve seat is to seal the combustion chamber against pressure losses and to provide a path to dissipate the heat accumulated in the valve head so as to prevent burning of the seat and warping of the valve head.

The location of the valve seat on the valve face and its width, controls the amount of valve head that protrudes into the combustion chamber. It is obvious that the greater the exposure within the combustion chamber, the higher the valve temperature; or in other words, the more heat it will collect. High valve temperature and poor heat dissipation also produce excessive valve stem temperatures. This will hasten the accumulation of carbon on the stems, causing them to stick in the guides.

Refacing Seats

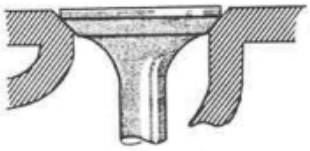
Remove all carbon, scale and oil before attempting to reface valve seats. The grinding stone, when placed against an oily seat, will become fouled, and uneven grinding will occur.

NOTE: Before installing the pilot, be certain that the valve guides are perfectly clean and meet the engine specifications. This is important; otherwise, an eccentric seat will be cut.

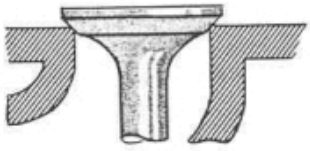
Dress the stone to the correct angle. Lightly lubricate and install the pilot of the correct size into the valve guide bore.

Lower the grinder head over the pilot shank until the stone just clears the valve seat. Turn on the power and very gently allow the stone to contact the valve seat. Very little pressure other than the normal weight of the stone should be used. Sudden hard pressure can cause cocking of the pilot in the guide and result in eccentric grinding. Raise the stone frequently from the valve seat to prevent overheating and to clear away grinding dust. Grind the seat sufficiently to provide an even, smooth surface.

Correct Seat



Seat too wide



Seat too narrow

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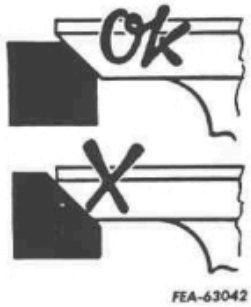


FEA-63042

Check the seat concentricity, roundness and valve face contact using Prussian blue. Spread an extremely thin film of this blue on the valve face and insert the valve into its guide. With pressure on the exact center of the valve head, make a quarter turn rotation in the seat. Remove the valve and inspect the impression made upon the seat by the transfer of blueing, and upon the valve face by the removal of blueing. Check several times to guarantee that no error was made. If a full seat-width contact around the entire circle of seated valve is not shown, the angles do not match. It will then be necessary to re-dress the valve seat grinding stones, changing the angle sufficiently to correct the error. The correction should be made on the valve seat, and not on the valve.

The location of the area of contact between the valve and the seat is a very important factor in securing maximum valve life. Seating the valve with the sharp edge of the seat not contacting the valve face is undesirable. This sharp edge tends to break off face deposits which may lead to valve failure.

Similarly, the location of the upper line of contact well below the top of the valve face, is also undesirable because a large overhang prevents rapid cooling of the outer edge of the valve.

After grinding the seats it may be found that the seats are considerably wider than the specified width of 3/64 inch. Valve seats that are too wide may be narrowed by grinding down the top edge of the seat with a stone mounted on the grinder head. The stone must be a smaller angle than the valve seat (15° preferably).

Reassembly

1. Coat the valve stems with engine oil and insert the intake and exhaust valves into their original positions.

2. Install the valve springs and valve spring seats. Compress the valve springs and install the valve seat retainer keys. Release the springs and remove the valve compressor.

3. Adjust the valve tappets. Refer to page 1-15.

4. Install the valve tappet cover using a new gasket.

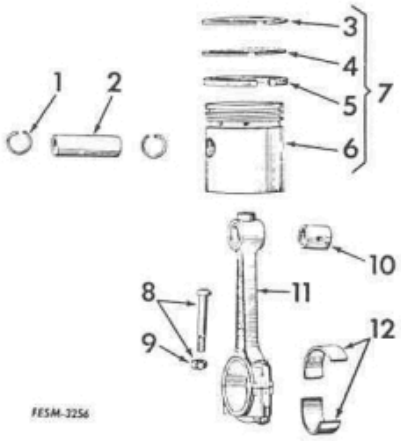
5. Install the intake and exhaust manifold assembly using a new gasket. Tighten the nuts evenly in steps to 20 ft. lbs. torque.

6. Install the cylinder head. Refer to page 1-14.

7. Refill the radiator with coolant.

CONNECTING RODS, PISTONS AND PISTON RINGS

General



1. Retainer
2. Pin
3. Compression ring
4. Compression ring
5. Oil control ring
6. Piston
7. Piston with rings
8. Bolt assembly
9. Nut
10. Bushing
11. Rod assembly
12. Bearing Assembly

Connecting Rods

The connecting rods serve as the links between the pistons and the crankshaft. The surfaces of the rods must be kept free of scoring and dents because of the high stresses under which they function. The rod has a bushing at each end, the one at the upper end is a bushing for the piston pin which anchors it to the piston. The bearing at the crankshaft or lower end is inserted in two halves which fit around the crankshaft and are secured by a bearing cap. The bearing cap is furnished only with its connecting rod.

The lower bearings used in these engines are the replaceable insert type and insure correct running clearances when they are properly installed. This is possible without boring, reaming, scraping or using shims. The three important fundamentals on bearings and bearing fitting are "bearing crush," "bearing spread," and "bearing clearance." An explanation of these will be covered later.

Pistons

The piston is one of the most important units in the engine, and its condition has much to do with the performance of the engine. Its function is to receive the force of the combustion pressure and transmit it to the connecting rod and crankshaft. The escape of combustion pressure past the piston is prevented by the piston rings. The fit of the piston and rings in the sleeve must be close enough to prevent the escape of combustion gases but must be free enough to keep friction to its working minimum.

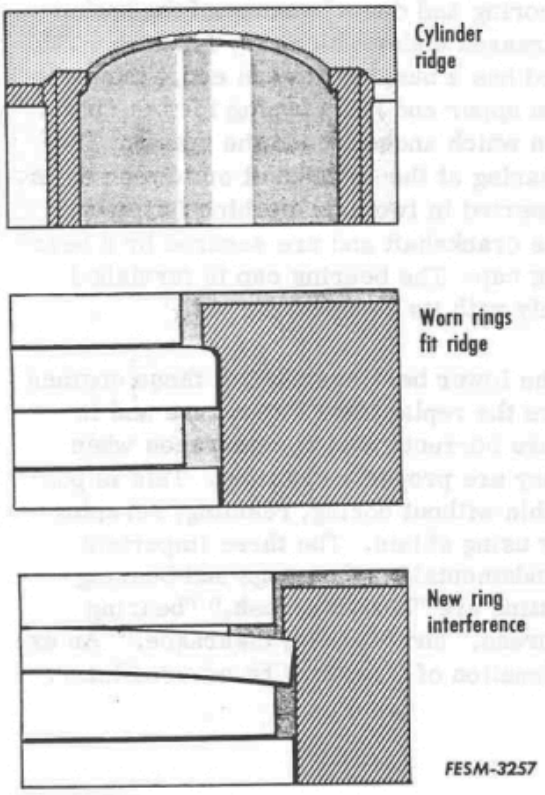
Piston Rings

The pistons are fitted with three piston rings. One oil regulating ring is fitted to each piston. The oil regulating ring provides an even circulation of lubricating oil and, therefore, an all over lubricating and cooling action for the piston and crankcase cylinder. Excess oil is wiped by the rings, back down to the crankcase. The remaining rings are compression rings. Rings should be installed on a piston so that the gaps are 90 degrees from the thrust side of the piston and 180 degrees from one gap to another.

Piston Pins

The piston pin is made of steel and is cylindrical in shape. Its purpose is to anchor the piston to the connecting rod. The pin is retained in the piston by retainer rings that lock into grooves of the piston pin bore. The pin is allowed to float in its bushing in the upper end of the rod. It is usually necessary to heat the piston in order to remove the pin.

Removal



1. Remove the cylinder head. (Refer to page 1-13.)

2. Remove the drain plug and drain the engine lubricating oil from the crankcase oil pan. Replace the drain plug.

3. Remove the cap screws securing the oil pan, and remove the oil pan and gasket.

IMPORTANT: Before proceeding with piston and connecting rod removal, the ridge, existing on the cylinder wall at the upper end of the ring travel, must be removed by using a ridge reamer. This prevents damage to the piston ring lands during removal of pistons, and prevents damage to new top piston rings after the installation of new rings.

4. Remove the oil pump screen and tube assembly.

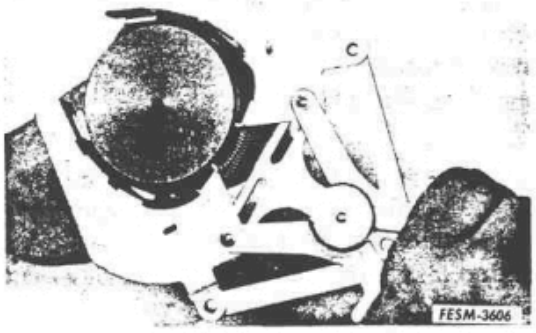
5. Remove the connecting rod bearing cap nuts. Remove the bearing cap. Be sure that each bearing and cap can be identified with the connecting rod from which it was removed. Each connecting rod should be found numbered on the camshaft side of the rod, indicating its position in the engine.

6. Push the connecting rod and piston assembly to the top and lift out from the crankcase. Replace the cap on the connecting rod to avoid damage.

IMPORTANT: Pistons must be handled carefully to avoid damage and knocking out-of-round or alignment. When removing a piston from the crankcase, do not allow the skirt of the piston to strike the crankcase or connecting rod. Mark the pistons so they can be installed in the same position and cylinder from which they were removed. The dome of the piston is stamped with an arrow, indicating its position when properly installed.

7. Crank the engine by hand to make each rod and cap accessible and remove all pistons and connecting rods in the same manner.

Disassembly



1. Remove the piston rings with a piston ring expander. Remove the top ring first and the remaining rings in order.

2. Remove the piston pin retainer rings.

3. Remove the piston pins from the pistons. As an aid in removing the pin, heat the piston in hot-to-boiling water and then remove the pin, being careful not to damage the piston.

Inspection and Repair

1. Wash all parts in a cleaning solvent. Clean the carbon from the piston ring grooves with a broken ring or ring groove cleaner.

2. Inspect the connecting rods, caps, bearing shells and pin bushings as follows:

(a) All connecting rod bearings and piston pin bushings should be replaced in a major overhaul.

(b) Test rods for alignment. Rods only slightly misaligned can be straightened using the proper equipment. Badly twisted or bent rods must be replaced.

3. Inspect the pistons for cracks, breaks or scores.

4. Measure the piston skirt at right angles to the pin to determine if it is worn excessively; replace if necessary. The specified piston diameter is 2.6230 to 2.6234 inches.

NOTE: On a used piston, it will probably be found that the piston ring side clearances tend to increase toward the top of the piston due to the higher operating temperature prevalent at this point. When this side clearance becomes excessive, the piston will have to be replaced.

5. Measure the crankcase cylinder bores for excessive wear. The specified bore ID is 2.625 to 2.627 inches. Replacement pistons are available in .020 and .040 inch oversizes.

6. Inspect the piston pins for wear; if wear is perceptible, replace pins. Replace piston pins showing signs of corrosion or etching. Specified piston pin diameter is .6875 to .6876 inch.

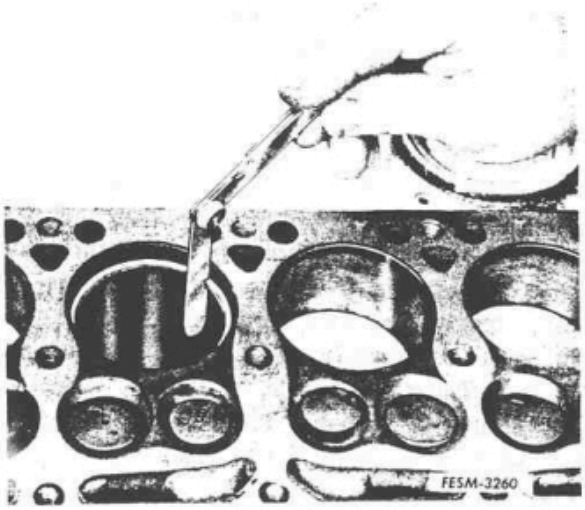
7. Inspect the connecting rod bushings for scratches and burrs. Replace if necessary.

8. Connecting rod bolts must be cleaned of all foreign matter including the anti-rust materials that may be caked in the threads. This is also true of the connecting rod bolt nuts.

A good method of checking to determine thread condition is to turn the connecting rod bolt (threads lubricated with a light engine oil) all the way into a standard nut with the fingers. If the bolt runs in relatively free without sticking or without the need for applying more than a very light (2-4 foot-pounds) wrench effort, the bolt is satisfactory for use.

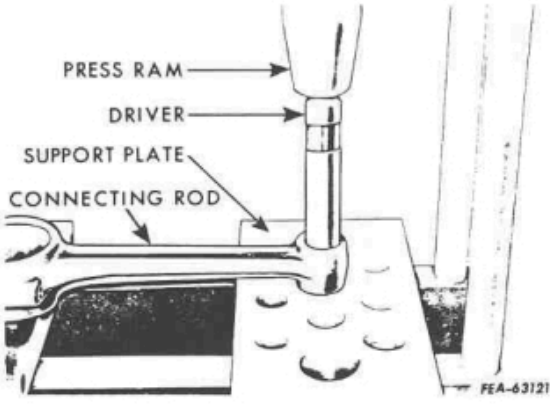
9. Rings should be checked also for the specified side clearance by measuring the clearance between the piston ring and the piston ring land as shown.

10. Inspect the piston rings for damage. Faulty rings cannot always be detected by the eye. Engine performance and irregularities such as excessive oil consumption must be taken into consideration. Whereever there is doubt as to the serviceability of the piston rings, it is advisable to replace such parts.



11. Insert each ring into the cylinder bore for that piston. Force them squarely down inside the sleeve or cylinder bore. Position a feeler gauge between the ends of the ring, and compare the existing gap against the specified gap. If it is necessary to remove material from the ring ends because the end gap is too close, clamp a mill file in a vise, hold the ring in proper alignment and dress off the ends squarely to obtain the desired gap.

12. Inspect the "windows" of the oil regulating ring and piston for blocked oilways. Failure to keep the oilways clear will result in uneven lubrication and "hot-spots" of the piston and cylinder sleeve. All rings should fit loosely in the piston grooves without binding.



13. Place connecting rods in an arbor press and press old piston pin bushings from the connecting rods.

14. Align the new piston pin bushing on the connecting rod so that the oil hole in the bushing will match with the oil hole in the connecting rod. Press the bushing into the rod.

15. Press the bushing into place in the connecting rod and then ream to provide the specified piston pin clearance of .0003 to .0007 inch.

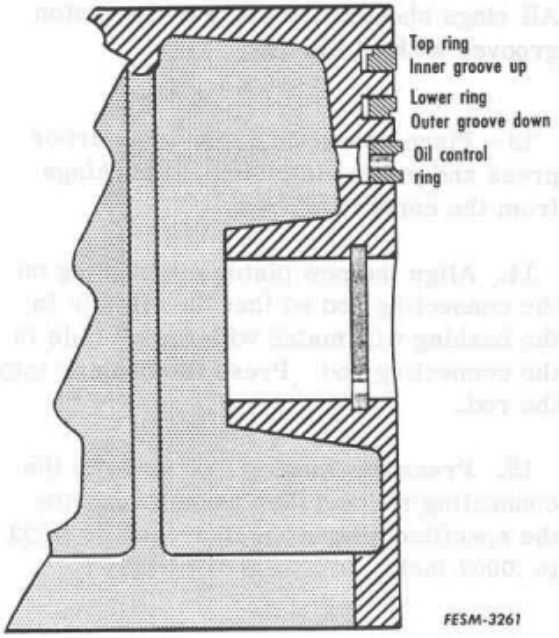
Reassembly

1. Before assembling the piston and connecting rod, check the fit of the piston pin in the piston for proper end clearance as follows:

(a) Prepare the piston and the pin for assembly as outlined in Step 2.

(b) Push the pin into the piston and install a retainer ring at each side of the piston.

(c) Push one end of the piston pin until it stops against the retainer ring on the opposite side of the piston.



(d) Using a feeler gauge, in the gap between the piston pin and the retainer ring, check for end clearance. Specified end clearance is .010 to .030 inch.

(e) Remove the retainer rings and proceed with the assembly as follows:

NOTE: When assembling the pistons to the rods, the front of the piston will be indicated by an arrow.

2. With the piston pin at room temperature (70°) and generously coated with clean engine lubricating oil, and the piston heated in hot water to approximately 150°F the piston pin can be entered into one boss of the piston by pushing with the hand. While the piston is hot, quickly and correctly position the connecting rod inside the piston, align the bushing in the rod bore with the piston pin holes in the piston and push the piston pin completely into position. Thoroughly dry the piston with compressed air.

3. Install a retainer ring in the groove at each side of the piston to secure the piston pin.

4. Using a piston ring expander, install the rings, oil control ring first, into the grooves of the pistons.

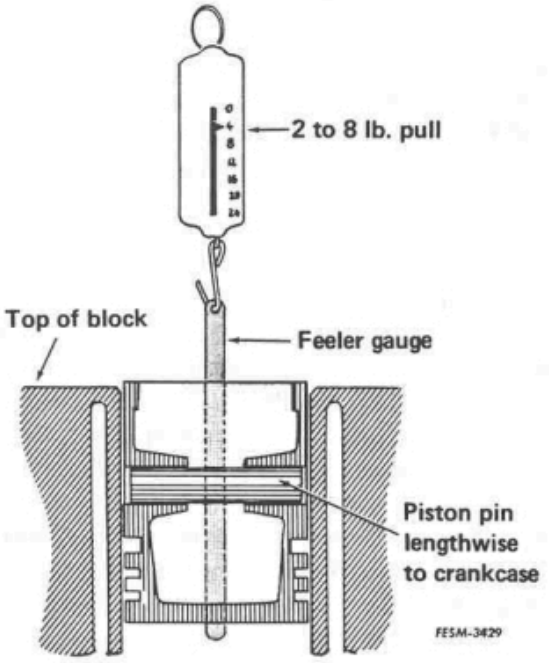
Position the ring gaps 90 degrees from the thrust side of the piston (in line with the piston pin bore) and 180 degrees from one gap to another.

Be sure the compression rings are installed with their grooves positioned as shown.

Piston Fit in Bore

Specified piston-to-bore clearance is .0016 to .0024 inch and can be determined using a 1/2 inch wide feeler gauge and a spring-type tension scale (FES 108).

The thickness of the feeler gauge that can be removed with a 2 to 8 pound pull represents the piston-to-bore clearance as outlined in the "Piston Clearance Chart." Clearances should conform to specifications.



PISTON CLEARANCE CHART

Pull in Lbs.	Feeler Gauge Thickness					
	.0015	.002	.003	.0035	.004	.0045
	Clearance in Inches					
2	.0016	.0022	.0033	.0039	.0044	.005
4	.0013	.0018	.0029	.0035	.004	.0046
6	.001	.0015	.0026	.0031	.0036	.0042
8	.0008	.0013	.0023	.0028	.0033	.0038

The chart shows the relationship between the feeler gauge thickness and pounds pull in measuring piston-to-bore clearance. Note that with a given feeler gauge thickness the actual clearance is less than the feeler gauge used when the pound pull is towards the high side of the pound pull range. This is especially true with the thinner feeler gauges.

To determine piston-to-bore clearance proceed as follows:

1. Select a feeler gauge (free of dents or burrs) of one of the thicknesses listed in the chart. Position the feeler gauge in the cylinder bore so that it extends the entire length of the piston 90° from the piston pin location.

2. Invert the piston and install it in the bore so that the end of the piston is about 1-1/2 inches below the top of the cylinder block and the piston pin is parallel to the crankshaft axis.

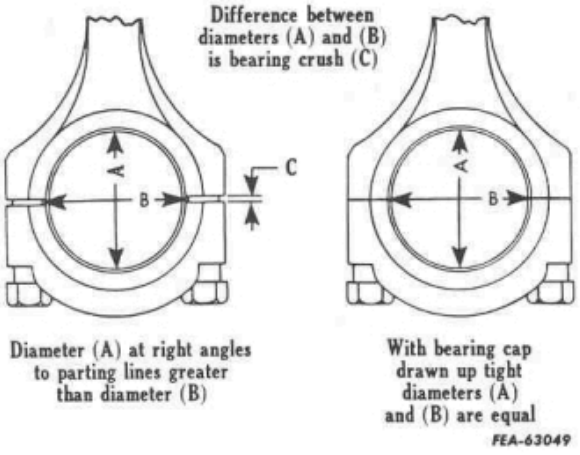
3. Hold the piston and slowly pull the scale in a straight line with the feeler gauge, noting the pull required to remove the feeler gauge. Check three times and record the average of the three readings obtained. Do not bend or kink the feeler gauge.

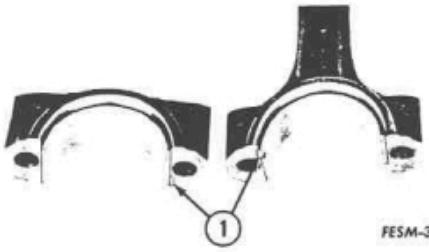
4. Refer to the chart to determine the actual clearance. The clearance is shown where the horizontal column indicating pounds pull and the vertical column indicating the thickness of the feeler gauge used intersect.

EXAMPLE: If a .003 inch feeler gauge is used and it takes 8 pounds pull to remove the feeler gauge, the clearance is .0023 inch.

5. Repeat step 3 with the piston at right angles to the crankshaft axis. Determine the clearance as instructed in step 4.

6. Measuring piston-to-bore clearance with the piston pin parallel and at right angles to the crankshaft axis will reflect any "out of round" in the bore.


Difference between diameters (A) and (B) is bearing crush (C)
A
B
C
A
B
Diameter (A) at right angles to parting lines greater than diameter (B)
With bearing cap drawn up tight diameters (A) and (B) are equal
FEA-63049



1. Bearing locking tangs

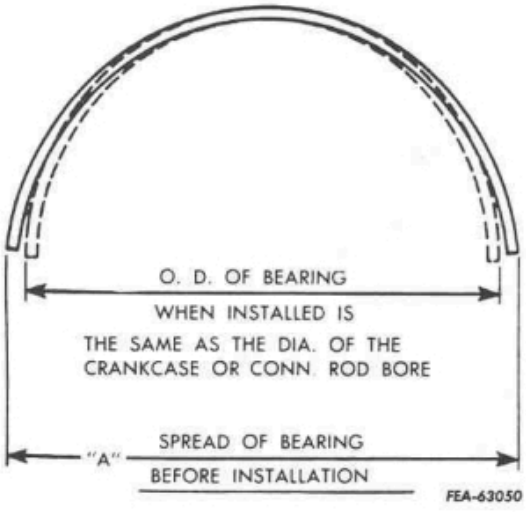
Bearing Fitting Procedure

CAUTION: Bearings or bearing caps must not be filed, lapped or modified in any manner to reduce journal-to-bearing clearance. Premature bearing failure will result from attempts to reduce journal-to-bearing running clearances. While such methods will make a tighter fit at the top and bottom of the bearing, it will result in an out-of-round bore and distortion of the bearing shell. New bearing shells will have to be installed eventually and additional problems will be encountered. Such modification alters the engineered fit of the bearing shells in their bores and destroys the desired "crush".

1. When installing precision type bearings, it is important that the bearing shells fit tightly in the rod or crankcase bore. To accomplish this, the diameter of the bearing at right angles to the parting line is slightly larger than the actual diameter of the bore onto which the bearing will be assembled. When the bearing cap is drawn up tight the bearing is compressed, assuring a positive contact between the bearing back and bore. The increased bearing diameter is called "bearing crush".

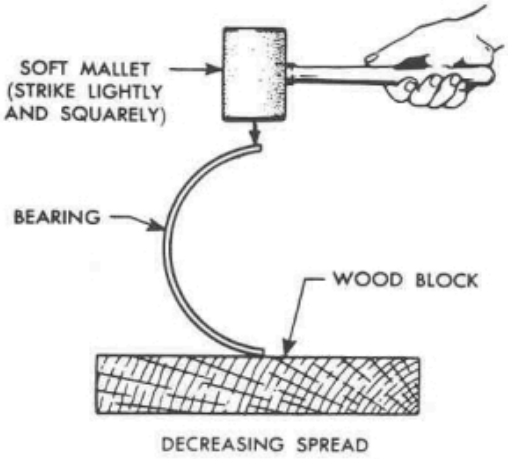
Be certain the bearings are fully seated and the locking tangs (1) on the bearings fit into the recesses.

2. To assemble the bearings with the correct "bearing crush," tighten the clamping bolts alternately and evenly to the specified torque with a torque wrench.

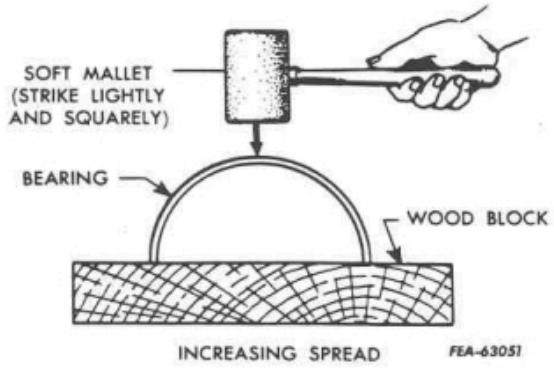


3. Main and connecting rod bearings are designed with the "spread" (width across the open ends) slightly greater than the diameter of the crankcase bore or connecting rod bore into which they are to be assembled. For example, the width across the open ends of the connecting rod bearing not in place is approximately .025 inch more than when the bearing is in position in the rod. This condition causes the bearing to fit snugly in the rod bore and the bearing must be "snapped" or lightly forced into its seat.

Rough handling in shipment, storage, or normal use in an engine, may cause the bearing spread to be increased or decreased from the specified width. Bearing spread should therefore be carefully measured and corrected as necessary before installation in an engine. Bearing spread can be safely adjusted as follows if care and judgment are exercised.

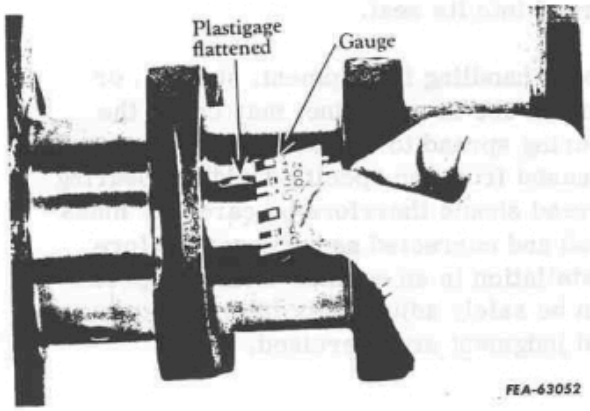


(a) EXCESSIVE SPREAD: If measurement of bearing indicates that dimension "A" is excessive, place bearing on a wood block and strike the side lightly and squarely with a soft mallet. Recheck measurement and, if necessary, continue until correct width is obtained.



(b) INSUFFICIENT SPREAD: If measurement of bearing indicates insufficient spread, place bearing on a wood block and strike the back of the bearing lightly and squarely with a soft mallet. Recheck measurement and if necessary continue until correct width is obtained.

4. BEARING CLEARANCE: When installing bearings in an engine, the proper clearance between bearing surface should be checked closely. Specified bearing clearance is .002 to .003 inch. To get an accurate measurement of this clearance, the "Plastigage" method, or virgin lead, can be used. The following instructions can be used when measuring with "Plastigage":



(a) Remove bearing cap and wipe bearing surface and exposed half of crankshaft journal free of oil.

(b) Place a piece of "Plastigage" the full width of bearing insert.

(c) Reinstall the bearing cap and tighten the self-locking cap screws to 16 foot-pounds torque.

(d) Remove the bearing cap. The flattened plastic material will be found adhering to either the bearing shell or the crankshaft.

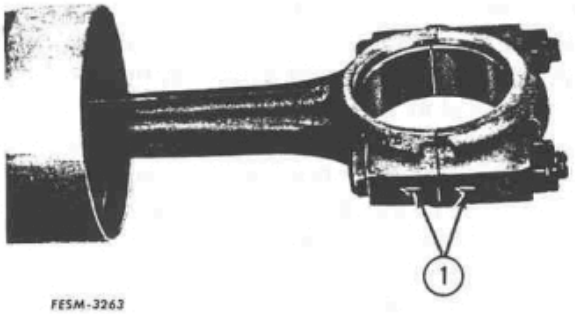
(e) To determine the bearing clearance, compare the width of the flattened plastic material at its widest point with the graduations on the envelope. The number within the graduation on the envelope indicates the clearance in thousandths of an inch.

(f) If using virgin lead, carefully remove the flattened lead and measure its thickness with a micrometer.

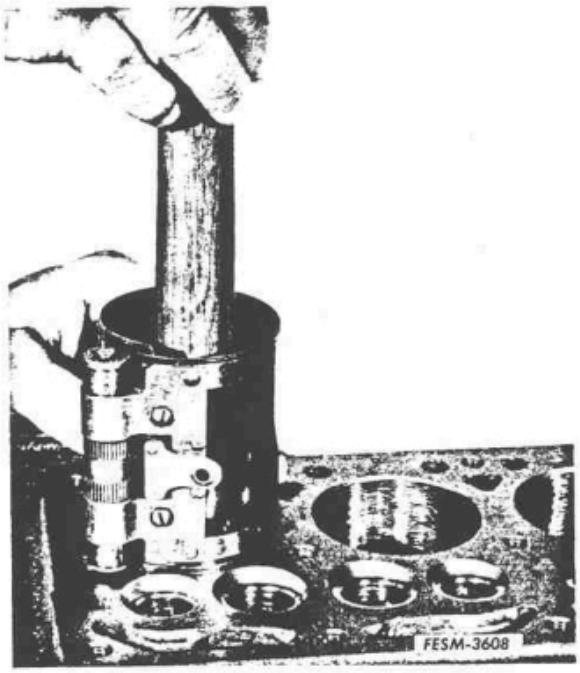
NOTE: Do not turn crankshaft during the above procedure.

Should the readings not fall within the specified limits, and the torque wrench is known to be accurate in its measurement, remove the bearing from the connecting rod and replace it with a new one. However, with the precision bearings used, no difficulty should be encountered providing the crankshaft and/or connecting rod are in proper condition.

Installation



1. Cylinder number toward camshaft



NOTE: When reinstalling a piston and connecting rod assembly, install the assembly in the same cylinder bore and in the same position from which it was removed. Connecting rods are stamped with the cylinder number on one side of the rod and on the same side of the bearing cap, No. 1 starting at the front end of the engine. Be sure to install the numbered side of both the rod and bearing cap so both are on the camshaft side of the engine.

1. Generously coat the piston ring compressor and bore with lubricating oil. Install the ring compressor on the piston and insert the piston and connecting rod assembly through the top of the crankcase.

2. Push down on the piston carefully until it is in the crankcase bore.

3. Wipe clean and oil the crankshaft journals and fit the connecting rod bearings as outlined in "Bearing Fitting Procedure."

4. Install all the pistons, connecting rods and bearings in the same manner.

5. Check the connecting rod side clearance by inserting a feeler gauge between the bearing cap and lobe of the crankshaft. The specified side clearance is .005 to .012 inch.

6. Install the oil pump screen and tube assembly.

7. Install the crankcase oil pan and new gasket. Fill the crankcase to the level on the gauge with the grade of engine oil specified in Operator's manual.

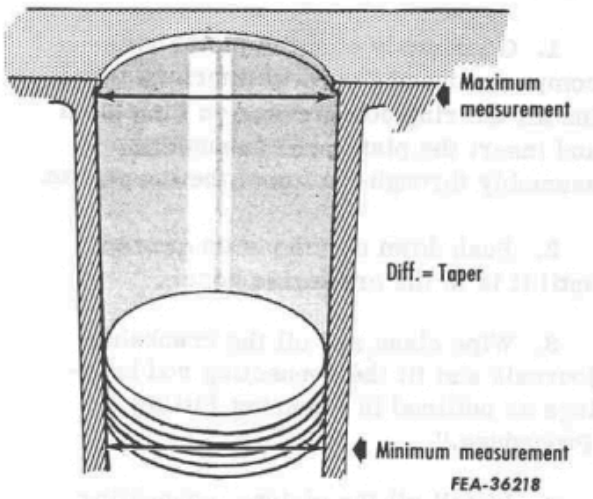
8. Install the cylinder head and gasket. (Refer to page 1-14.)

Crankcase Cylinder Re-Boring Procedure

This section covers re-boring of the cylinder bore with the engine disassembled. However, if re-boring is the only service to be performed on the engine, the crankshaft need not be removed.

When to Re-Bore

Replacement piston ring kits may be used to extend the life of the piston if cylinder wear has not been excessive. Inspect cylinder bores for scoring and roughness which indicate excessive wear. Check cylinder bores for taper and out-of-round by the use of a cylinder gauge placed at the top, middle, and bottom of bores, both parallel and at right angle to the centerline of crankshaft. To be within safe limits, the taper from top to bottom of the ring travel area must not exceed 0.005 in. and the out-of-round (egg-shape) condition must not exceed .005 in. in the cylinder bores. If the bore is worn beyond these limits, a re-boring job is required. It is advisable to re-bore for the smallest possible oversize pistons and rings. If only one or two bores require correction, it is not necessary to re-bore all cylinders to the same oversize.



Preparing the Block

Clean the water jacket with materials that will remove rust and scale and then flush thoroughly. Degrease the crankcase so that the abrasive material from the boring operation may be completely removed before reassembly.

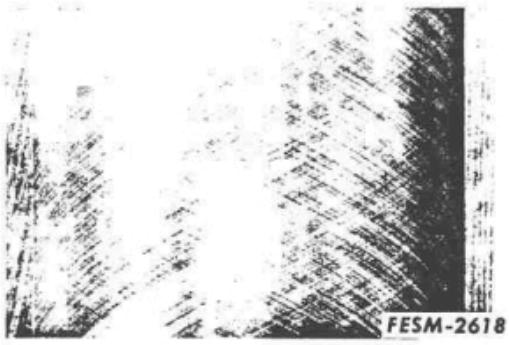
Before setting up a boring machine on the block, the top of block must be carefully cleaned to remove all foreign materials, such as carbon, rust, or gasket cement. Use a 14 in. fine-cut, mill file to draw-file the block for removal of all burrs and high spots around the top edge and bolt holes. This will provide a smooth, true working surface for the boring operation. This is very important because the alignment of the cylinder bores depends entirely on the tightness of this working surface.

Re-Boring

When re-boring cylinders, all crankshaft bearing caps must be in place and torqued to specifications to avoid possible distortion of bores in final assembly. If all bores require the same correction, to save time bore the cylinder having the greatest amount of wear and taper first. If this cylinder cleans up to the smallest desired oversize, you can be sure that the remaining, smaller cylinder bores will clean up to the same size. Oversize pistons furnished for service are .020 in. and .040 in. oversize. No attempt should be made to cut down oversize pistons to fit cylinder bores.

To center the boring machine on each cylinder, follow closely the instructions of the boring machine manufacturer.

NOTE: If the crankshaft has not been removed, be sure the crankshaft is out of the way of the boring cutter when boring each cylinder.



Use a good single point boring bar with a sharp tool and bore all cylinders the same size, to within .002 to .001 in. of the desired finished oversize to permit finishing honing operations.

Honing

For best results, hone the cylinders to the finished size. This operation must remove all boring tool marks. Final finish should be in the range of 20 to 35 microinches. If you have no means for measuring the finish, the use of about 120 grit stones will produce approximately the correct finish.

Cylinders that are too smooth will retard run-in and may result in ring scuffing. When cylinders are too rough, rapid ring wear will result. A rigid type wet hone is preferred for the final sizing operation, but a spring hone of the glaze-breaking type may be used if the other is not available. Spring hones should be equipped with 220 grit stones and stock removal should not exceed 0.003 in. This type of hone should be dipped into SAE 10 or 20 lubricating oil before beginning the operation. Dull or dirty stones cut unevenly and generate excessive heat. Keep honing equipment sharp and clean. When finished honing, pass the hone through the entire cylinder bore at a rate of 60 cycles per minute or as necessary to provide a 30 degree (relative to the top of the sleeve) cross-hatch pattern on cylinder walls. This will insure maximum ring life and minimum oil consumption.

Cleaning

The success of any re-boring job depends on the accuracy and smoothness of the finished bores, the amount of piston clearance, and the thoroughness with which you clean the block and crankcase of all cuttings and abrasive materials resulting from boring and honing. The best re-boring job will be a total loss unless the crankcase is thoroughly cleaned. Foreign material which remains causes rapid wear of pistons, rings, and cylinder walls, and will seriously damage engine bearings.

For thorough cleaning of the crankcase, washing in a tank of hot, agitated cleaning solution is the recommended procedure. If this cannot be done, use a good cleaning solution and air pressure blast followed by careful wiping with clean cloths and light lubricating oil. Surfaces should be wiped until a clean cloth shows no discoloration. Wash and blow out oil passages.

Checking Clearance

Refer to "Piston Fit in Bore", page 1-31.

TIMING GEAR TRAIN AND FRONT COVER

General

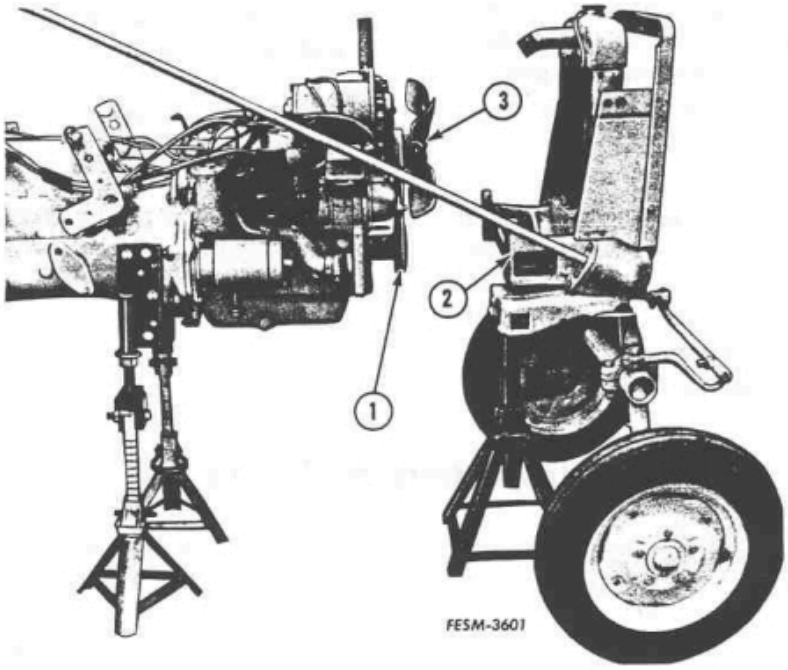
The crankcase front cover encloses the timing gear train. It is of one piece construction. It also provides mounting for the governor and ignition drive. The gear train is comprised of the crankshaft gear, camshaft gear, idler gear and the ignition unit and governor drive gear.

Removal

1. Support the engine and remove the radiator, steering gear housing assembly and front axle from the tractor.

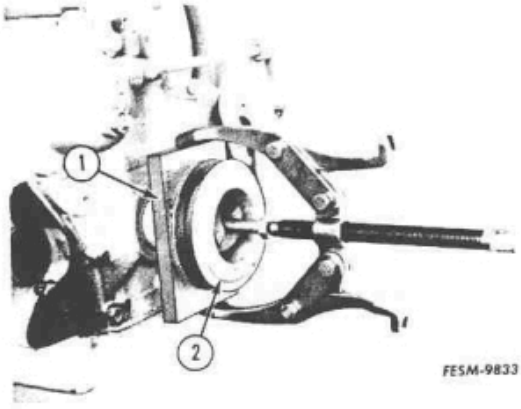
2. Remove the cooling fan assembly (3).

3. Remove the distributor and distributor drive.



1. Fan drive pulley
2. Steering gear housing assembly
3. Cooling fan assembly

4. Remove the engine governor assembly.



1. FES 33-1 Removing tool
2. Fan drive pulley

5. Remove the fan drive pulley from the crankshaft using removing tools FES 33-1 and a two jaw puller as shown.

NOTE: If the fan drive pulley has a wear sleeve installed, inspect the sleeve for excessive wear or damage. To remove the wear sleeve, indent the sleeve surface lightly with a blunt chisel. This will expand the sleeve for easy removal.

6. Remove the cap screws from the front cover, and remove the cover and gasket. Clean the gasket mating areas to insure proper sealing when reassembled.

NOTE: Before removing any gears it is advisable to check the backlash of the gears to determine which, if any, require service. Check the backlash with a dial indicator or feeler gauges. The specified backlash is .003 to .006 inch.

7. Remove the idler gear shaft bolt and remove the idler gear.

8. Remove the crankshaft gear with a puller.

9. Using a puller, remove the camshaft gear.

10. Remove the ignition drive seal.

Inspection and Repair

1. Clean all parts thoroughly in a cleaning solvent and dry with compressed air.

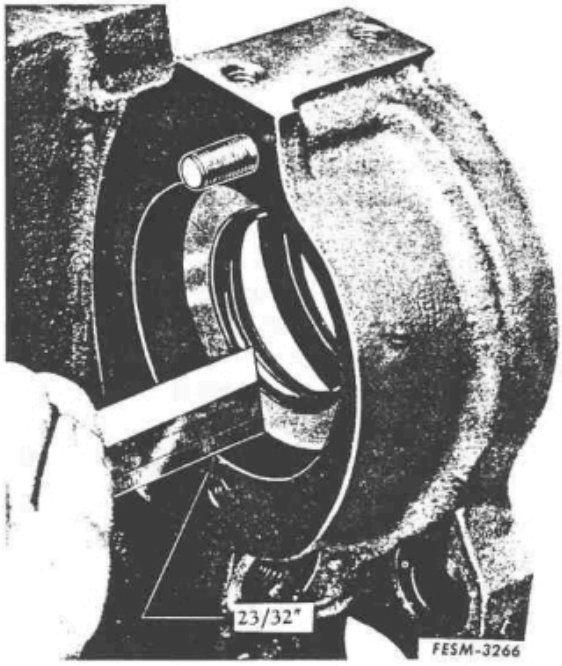
2. Remove all gasket material from the crankcase and front cover with a putty knife so that a clean surface can be had when the new gaskets are installed.

3. Inspect all gears for excessive wear, chipping or cracks.

4. Inspect all keys and keyways for wear or damage and replace as necessary.

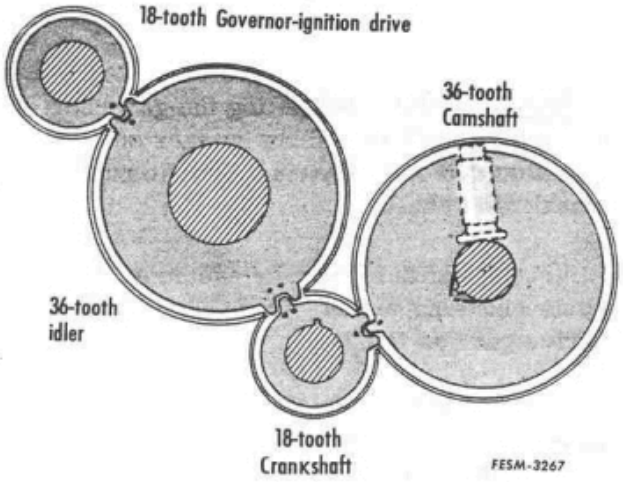
5. Be sure to install a new front cover oil seal and gasket.

Reassembly and Installation



1. Install a new ignition drive oil seal in the crankcase. The seal must be square in its bore and positioned 23/32 inch from the ignition mounting flange face.

2. Install the key in the camshaft if it was removed. Heat the camshaft gear in boiling water. Install the camshaft gear on the shaft with the timing marks facing out.

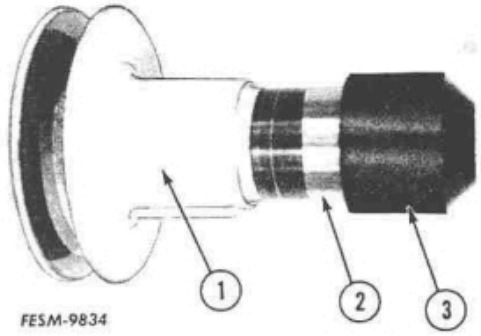


3. Install the key in the crankshaft if it was removed. Heat the crankshaft gear and install the gear, being sure the single timing mark of the camshaft gear and the single mark on the crankshaft gear are aligned.

4. Install the idler gear and shaft. Tighten the bolt to 90 ft. lbs. torque. The idler gear is correctly timed by lining up the double punch mark on the idler gear with the double punch mark on the crankshaft gear.

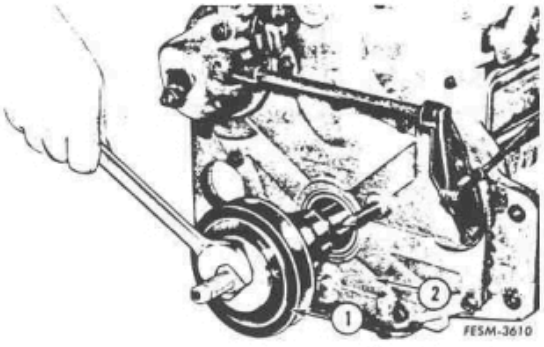
NOTE: Before installing the crankcase front cover, mark the top surfaces of the two teeth on each side of the single punch mark on the idler gear with chalk.

5. Install the crankcase front cover with a new oil seal and gasket. Do not tighten the cap screws at this time.



1. Fan drive pulley
2. Wear sleeve
3. FES 33-4 Fan drive pulley wear sleeve installer

NOTE: If necessary, install a new wear sleeve onto the fan drive pulley using the FES 33-4 fan drive pulley wear sleeve installer as shown. Be sure to apply a sealer onto the pulley O.D. or the I.D. of the wear sleeve before installing the wear sleeve onto the pulley.



1. Fan drive pulley
2. Crankcase front cover

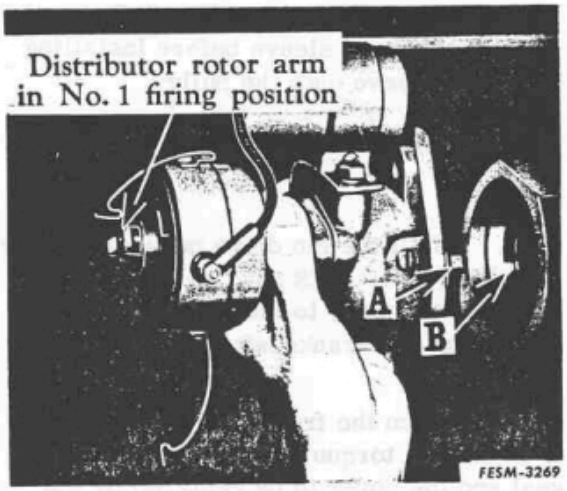
6. Install the fan drive pulley (1) using installing tool, FES 33-1 as shown. It may be necessary to block the flywheel to prevent the crankshaft from rotating.

7. Tighten the front cover cap screws to 20 ft. lbs. torque. This permits the seal and the cover to be centered by the fan drive pulley hub and insures an even contact of the seal around the pulley hub.

NOTE: Before installing the governor assembly, mark the front surface of the ignition drive gear having a single punch mark with chalk.

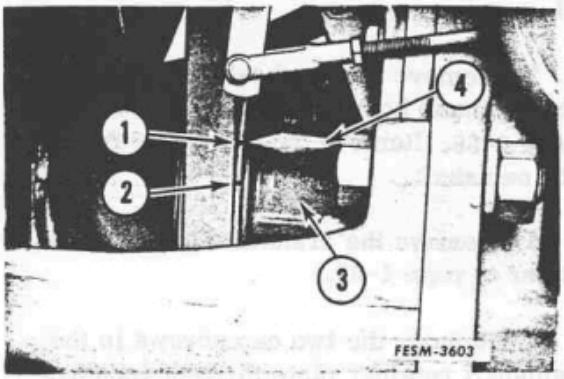
8. Install the governor assembly with a new housing gasket. Time the ignition drive gear as follows:

With the engine on top dead center of number 1 firing stroke, mesh the marked tooth of the ignition drive gear with the two chalk marked teeth on the idler gear.



9. Position the ignition unit distributor arm and drive shaft lug (A) for firing number one cylinder. Install the ignition unit on the engine, meshing distributor lug (A) and governor drive slots (B).

NOTE: Remove the secondary cables from No. 2, 3 and 4 spark plugs to prevent any chance of accidentally starting the engine.



1. T.D.C. mark
2. 16° mark (B.T.D.C.)
3. Fan drive pulley
4. Timing pointer

10. Place the number one spark plug cable in a position so that the spark to ground will be audible when hand cranking the engine. Then advance or retard the ignition distributor until spark occurs as the T.D.C. mark (1) on the fan drive pulley (3) aligns with pointer while hand cranking engine. Never time the spark before top dead center.

NOTE: Final ignition timing must be made with a timing light. The specified ignition timing is 16 degrees (2) before T.D.C. at 2000 engine rpm.

11. Install the cooling fan assembly. (Refer to page 1-62.)

12. Install the radiator assembly, steering gear housing assembly and front axle on the tractor.

CAMSHAFT

General

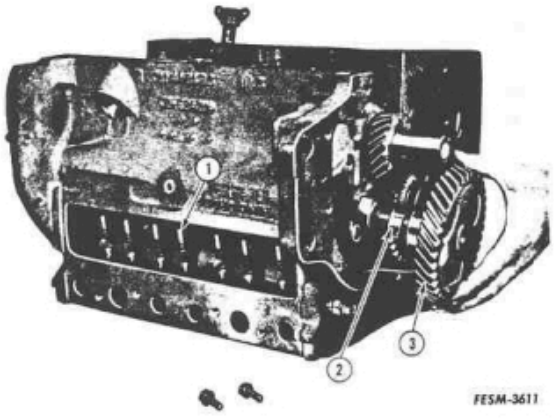
The camshaft is a single piece, drop forged shaft, with three bearing journals. The journals are supported by the machined bores in the crankcase. A helical gear, keyed to the shaft at the forward end of the camshaft is driven by the crankshaft.

The camshaft operates at one-half the engine speed.

The camshaft extends through the rear bearing bore into the oil pump body. This extended portion of the shaft is smaller in diameter than the rear bearing journal and carries a Woodruff key to drive the oil pump drive gear.

The camshaft has the main function of operating the intake and exhaust valve mechanism, by action of the lobes upon the valve tappets during rotation.

Removal



1. Tappets
2. Camshaft
3. Camshaft gear

Removal of the camshaft only, requires the removal of the engine from the tractor and removal of head, valves, oil pan, oil pump, flywheel and crankcase front cover from the engine.

1. Remove the valve tappet cover, and remove the valve assemblies. Refer to page 1-16. Be sure to identify each assembly for proper reassembly.

2. Remove the flywheel, and remove the oil pump body and gears. Refer to page 1-55. Remove the key in the rear of the camshaft.

3. Remove the crankcase front cover. Refer to page 1-38.

4. Remove the two cap screws in the camshaft retainer plate through openings in the cam drive gear.

5. Turn the crankcase upside down so the tappets (1) will fall away from the camshaft to provide clearance for removal.

6. Withdraw the camshaft (2) from the front carefully so the crankcase bores are not damaged by nicks from the edges of the cam lobes.

7. If necessary to remove the camshaft gear (3), press the gear off.

8. Remove the thrust plate and key if the camshaft gear was removed.

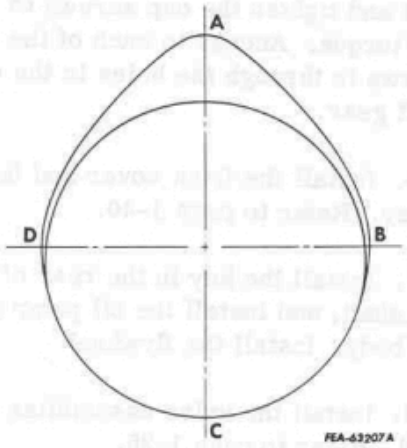
9. Lift the valve tappets out of the crankcase. Be sure to identify the tappets so they can be installed in their original bores.

Inspection and Repair

1. Clean all parts in a cleaning solvent and dry with compressed air. As inspection is completed, coat each part with clean engine oil and store safely until reassembly.

2. Inspect the camshaft journals for excessive wear. The specified journal diameters are 1.871 to 1.872 inches for the front, 1.746 to 1.747 inches for the center and .872 and .873 inch for the rear journal. If excessively worn or out-of-round, the camshaft must be replaced. Check any run-out on the camshaft using a dial indicator at the center bearing journal. Place the shaft in a lathe or between centering blocks. The total run-out must not exceed .002 inch.

3. Check the crankcase bearing bore inside diameters. The specified ID is 1.8740 to 1.8755 inches for the front, 1.7490 to 1.7505 inches for the center and .8740 to .8755 inch for the rear.



4. Inspect the camshaft lobes for excessive wear, chipping, scoring and replace if necessary. If the lifting areas of the cam lobes, when compared with new camshaft, show amount of wear exceeding .020 inch, the camshaft must be replaced. If a new camshaft is not available for comparison, the cam lobe wear can be measured with a micrometer in the following manner. Take a reading across A-C and deduct the reading B-D; this will give the lobe lift. When the cam lobe wear limit has been reached, this lift will be .020 in. less than the specified lift of .232 inch. The camshaft must then be replaced with a new one.

5. Replace the camshaft gear if the teeth are excessively worn, chipped or scored. Small nicks or burrs can be removed with a hone or fine mill file.

6. Check the condition of the thrust flange and replace if excessively worn.

7. Inspect the tappets. Replace any that are scratched or worn.

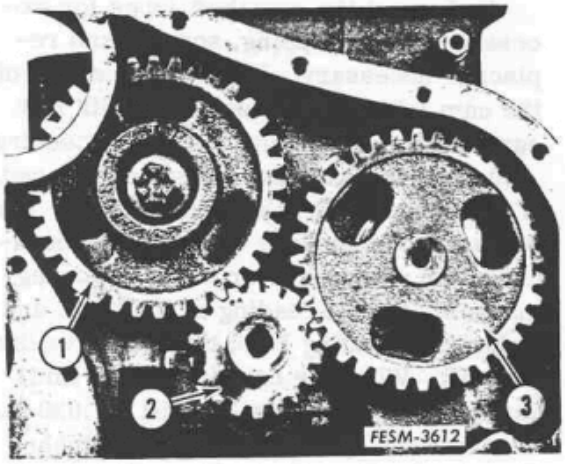
8. Be sure to use new gaskets in reassembly.

Installation

1. Install the valve tappets in their original bores.

2. Place the camshaft thrust plate on the shaft and install the key in the keyway. Heat the camshaft gear in boiling water and install the gear (with the timing mark facing out).

3. Check the end clearance with a feeler gauge between the camshaft front journal and the thrust plate. Be sure the drive gear is in place against the shoulder on camshaft. The specified end clearance is .003 to .012 inch. If the end play is excessive, replace the thrust plate with a new one.



1. Idler gear
2. Crankshaft gear
3. Camshaft gear

4. Coat the camshaft with engine oil and install the camshaft in the crankcase. Be sure the camshaft gear (3) is correctly indexed with the timing mark on the crankshaft gear (2).

5. Secure the thrust plate to the crankcase and tighten the cap screws to 20 ft. lbs. torque. Access to each of the two screws is through the holes in the camshaft gear.

6. Install the front cover and fan drive pulley. Refer to page 1-40.

7. Install the key in the rear of the camshaft, and install the oil pump gears and body. Install the flywheel.

8. Install the valve assemblies and head. Refer to page 1-25.

9. Install the oil pan.

10. Install the engine in the tractor. Refer to page 1-12.

11. Install the steering gear housing assembly, front axle and the radiator assembly on the front of the engine.

12. Start the engine and bring up to operating temperature.

(a) Inspect for oil leaks and check for correct engine oil pressure.

(b) Check and adjust the ignition timing.

(c) Check and adjust the valve clearance if necessary. Refer to page 1-15.

CRANKSHAFT AND MAIN BEARINGS

General

The crankshaft is supported in the crankcase by replaceable insert bearings. The precision-type bearings are not adjustable. When running clearances become excessive, replacement is necessary.

The connecting rods and all crankshaft journals are rifle-drilled to provide positive lubrication. Each main bearing cap, which contains the lower half of the insert bearings, is numbered consecutively to correspond with a number stamped on the camshaft side of the crankcase. The bearing caps are not interchangeable. No. 1 bearing cap is at the front of the engine.

CAUTION: Extreme care must be taken to guarantee cleanliness of the crankcase, crankshaft and bearings after service has been completed. Whenever possible, the crankshaft should be removed when new bearings are being installed in order to clean the crankcase thoroughly. All bearing surfaces must be free of grit and burrs. Small particles of dust and dirt left between the crankshaft and bearings will cause rapid wear and scoring of the crankshaft journal and insert. Any foreign material left between the bearings and the crankcase and bearing caps will cause distortion of the bearing and a reduction in operating bearing clearance at localized point. The frictional heat thus produced will in turn cause the bearing material to melt away from the steel back of the bearing at that point. Such melted material will create further hot spots until complete bearing failure takes place. Anything that interferes with the operating clearance of any bearing or the proper heat dissipation has its effect upon bearing life. Cleanliness cannot be overstressed.

The crankshaft front and rear oil seals will also be worn and should be replaced. This cleaning of the crankcase and replacing of oil seals is the best insurance against early bearing failures through dirt or foreign material left in the crankcase oil distribution bores or from dirt entering worn oil seals.

Main bearings are available in standard production size for new shafts or for used shafts having little or no wear and .002 inch undersize for shafts slightly worn. Also available are .010, .020 and .030 inch undersize for use with regound crankshafts. When servicing main bearings, one defective bearing will require the replacement of all three bearings; otherwise crankshaft "lay" or alignment cannot be maintained.

The replacement of crankshaft main bearings without removing the crankshaft should be done only in an emergency. When these bearings are worn sufficiently to require replacement or have failed through lack of lubrication, the entire crankcase and its oil distribution bores should be thoroughly cleaned. This cannot be accomplished without the removal of the crankshaft.

Removal

To completely service the crankshaft and bearings, the crankcase oil, cooling and hydraulic systems must be drained and the engine removed from the tractor. Refer to page 1-10.

1. Remove the fan drive pulley. (Refer to page 1-39.)

2. Remove the front cover. (Refer to page 1-38.)

3. Remove the flywheel and the rear oil seal retainer.

4. Remove the crankcase oil pan, and remove the oil pump screen and tube.

5. Remove the crankshaft bearing cap bolts. Tap the caps lightly with a lead hammer, if necessary, to dislodge them and remove squarely from position.

6. Remove the lower bearing from each cap. If they are to be reassembled, be certain that they are identified as to their original positions. Wrap them in clean cloths and store until reassembly.

NOTE: If the crankshaft is to be removed disregard step 7.

7. Remove the upper bearing halves from between the crankshaft and the crankcase with a thin piece of flexible soft sheet metal. Push against the end of the bearing without the positioning nut, while turning the crankshaft in the direction of rotation. The bearing will slide from position easily.

8. Remove the connecting rod bearing cap nuts and bolts and remove the caps. Push the piston and rod assemblies to the top of their travel.

9. Lift the crankshaft out of the crankcase.

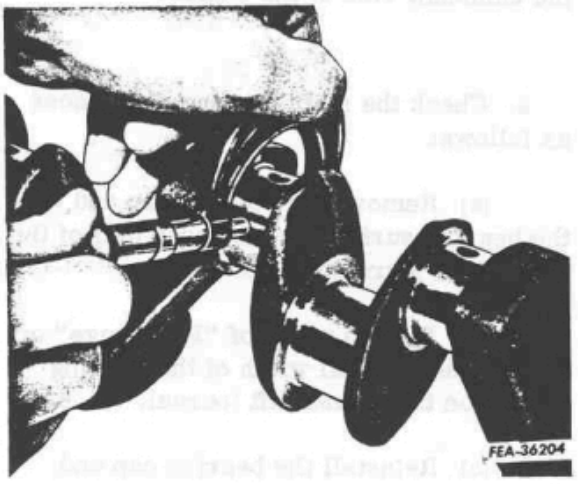
Inspection and Repair

1. Clean all parts with cleaning solvent and dry with compressed air.

2. Inspect the bearings for wear and evidence of uneven bearing support. Examine the bearing caps and supporting surfaces of the crankcase for high spots and burrs.

3. Inspect the crankshaft journals for scoring and measure the diameter of each journal with a micrometer. Specified journal diameter is 1.623 to 1.624 inches. Measure each journal at two points, one at right angles to the other, in order to detect any out-of-roundness.

Move the micrometer over the entire width of the journal.

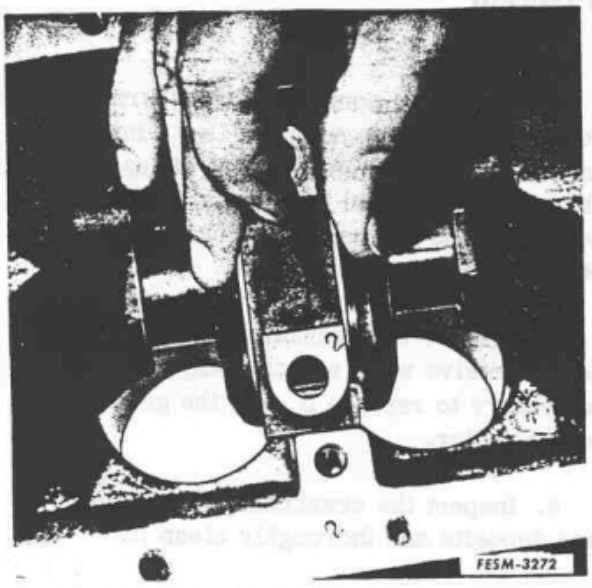


4. Check the connecting rod journals for out-of-round condition. Use a micrometer and take measurements at least three places around the journals. The specified rod journal diameter is 1.498 to 1.499 inches.

5. Inspect the crankshaft gear teeth for excessive wear and chipping. If necessary to replace it, pull the gear with a puller.

6. Inspect the crankcase for sludge and deposits and thoroughly clean it.

7. Replace all seals and gaskets with new ones.



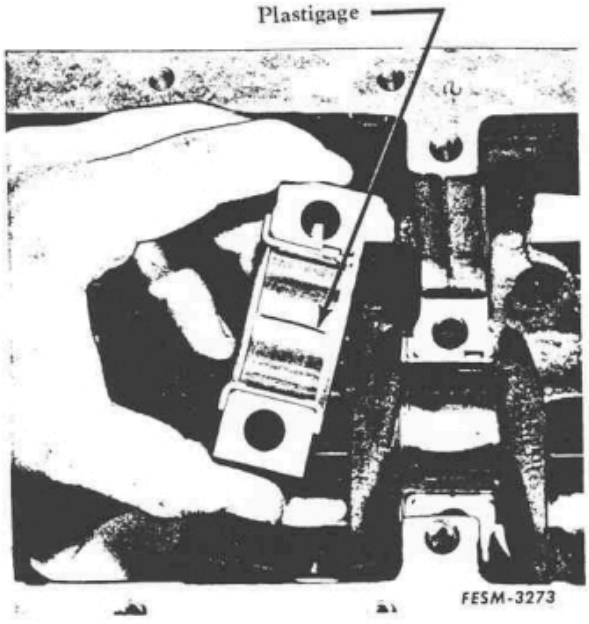
Installation

1. Wipe all surfaces of the crankshaft bearing bores of crankcase and bearing caps free of oil, and place bearing halves in the bore of the crankcase and bearing caps. Be certain the bearings are fully seated, oil holes are in alignment, and locking tangs on the bearings fit into the recesses.

2. Apply a film of engine oil on the bearing surfaces and place the crankshaft into position.

NOTE: When installing the crankshaft, be certain to correctly index the timing marks on the crankshaft gear with the idler gear and camshaft gear.

3. Install the bearing caps over the crankshaft journals, being certain to install the caps in their correct positions and with the numbered side of the caps to the camshaft side of the engine.



4. Check the main bearing clearances as follows:

(a) Remove the bearing cap and wipe the bearing surface and exposed half of the crankshaft journal free of oil.

(b) Place a piece of "Plastigage" or virgin lead, the full width of the bearing insert, on the crankshaft journal.

(c) Reinstall the bearing cap and tighten the cap screws to 55 foot-pounds torque.

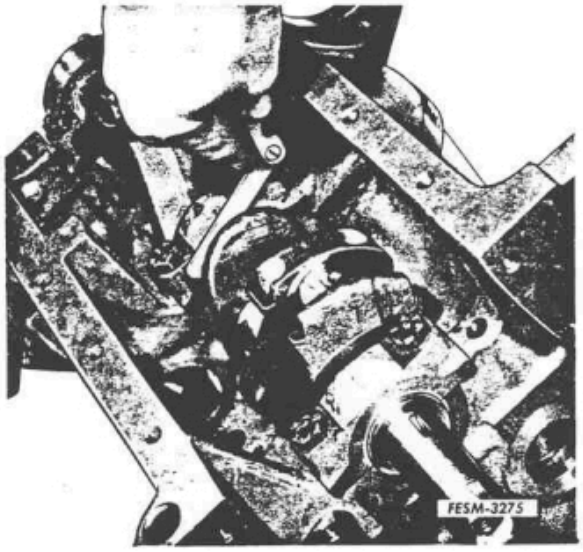
(d) Remove the bearing cap. The flattened section of the virgin lead or "Plastigage" represents the clearance present between the bearing surface and the crankshaft journal. Measure the thickness with a micrometer or match the flattened Plastigage at several points (on either the bearing insert or the crankshaft), with the corresponding graduation on the Plastigage envelope, which indicates the clearance in thousandths of an inch. Running clearance must be .002 to .003 inch.

NOTE: Do not turn the crankshaft during the bearing clearance check.

(e) Should the readings not fall within the specified limits, and the torque wrench is known to be accurate, remove the bearing and replace it with a new one. However, with the precision bearings used, no difficulty should be encountered providing the crankshaft and/or crankcase and caps are in good order.

5. Install the bearing caps to their original position and tighten the cap screws to 55 ft. lbs. torque.

NOTE: When installing center main bearing cap, hold crankshaft against the rear thrust face of the upper half of the bearing. Tighten center cap bolts lightly and tap cap toward the rear before final tightening of cap bolts. This lines up the upper and lower thrust surfaces of the bearing halves and prevents binding the shaft on the thrust surfaces.



6. Check the crankshaft thrust bearing side clearance with a feeler gauge at the front side of the center bearing on both upper and lower thrust faces. Specified side clearance is .004 to .008 inch.

While making this check, be sure the crankshaft is held against the rear thrust face of the bearing to show total clearance at front side.

7. Install the connecting rod bearings and caps. Refer to page 1-35.

8. Install the hydraulic oil pump (if so equipped).

9. Install new front and rear crankshaft oil seals in their retainers.

10. Install the rear oil seal retainer.

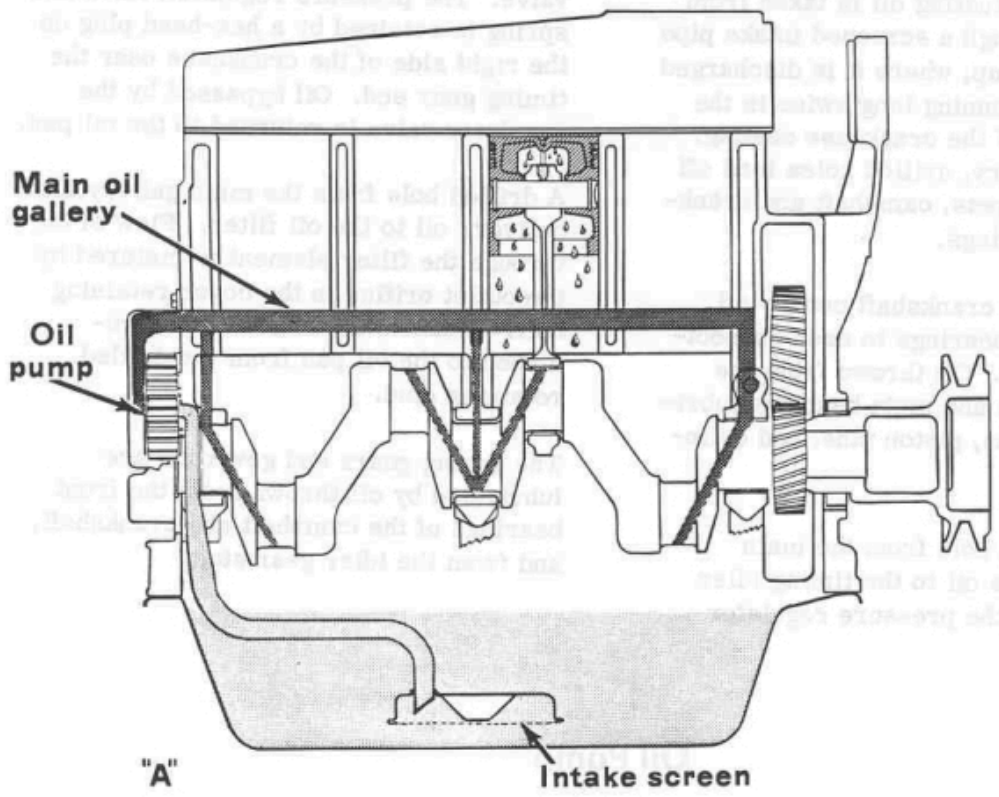
11. Install the flywheel and secure with the cap screws. Tighten the cap screws to 45 ft. lbs. torque.

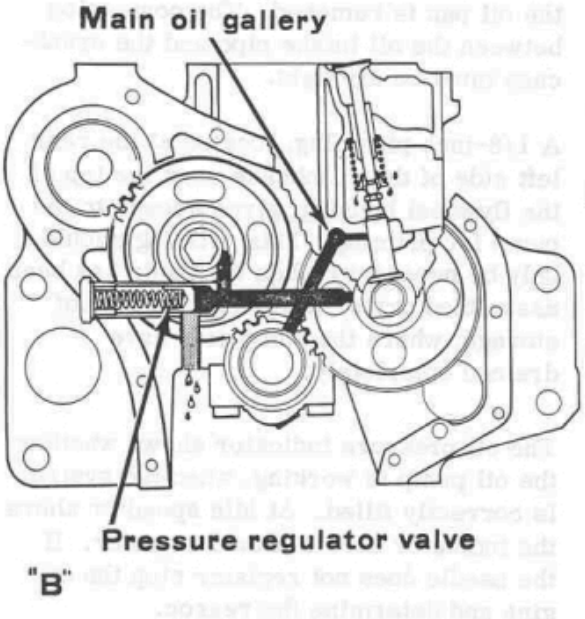
12. Install the oil pan.

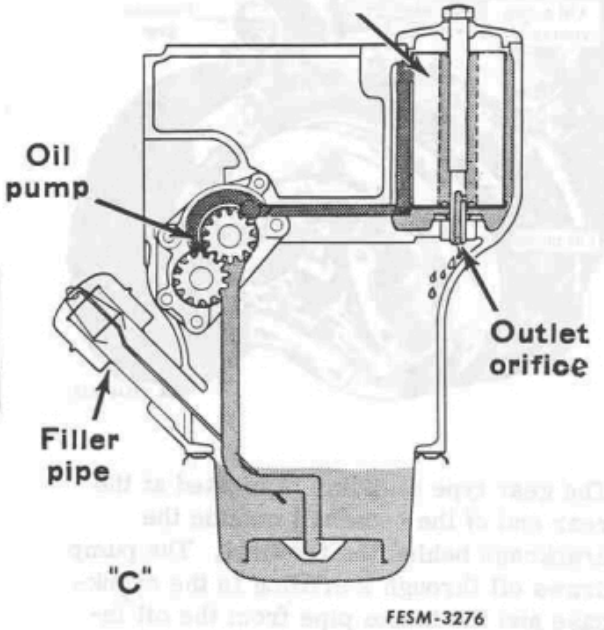
13. Install the front cover and the fan drive pulley. Refer to page 1-40.

14. Install the engine in the tractor. Refer to page 1-12.

Lubricating Oil Pump







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General Description

The engine lubricating oil is taken from the oil pan through a screened intake pipe up to the oil pump, where it is discharged into a gallery running lengthwise in the left hand side of the crankcase casting. From this gallery, drilled holes lead off to the valve tappets, camshaft and crankshaft main bearings.

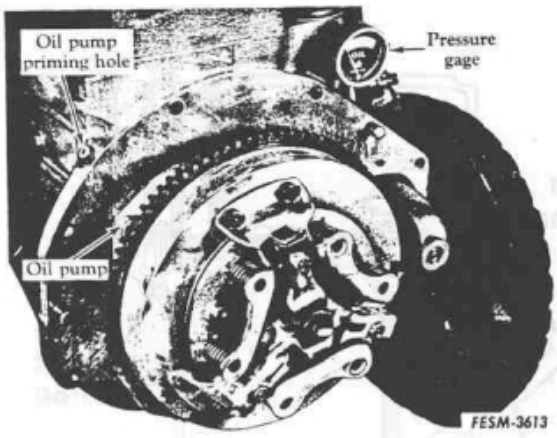
Drillings in the crankshaft convey oil from the main bearings to each connecting rod bearing. Oil thrown from the connecting rods and main bearings lubricates the pistons, piston pins, and cylinder walls.

Another drilled hole from the main gallery supplies oil to the timing idler gear stud, and the pressure regulator valve. The pressure regulator valve and spring is retained by a hex-head plug on the right side of the crankcase near the timing gear end. Oil bypassed by the regulator valve is returned to the oil pan.

A drilled hole from the main gallery also delivers oil to the oil filter. Flow of oil through the filter element is metered by the outlet orifice in the cover retaining bolt. Cleaned and filtered oil is returned to the oil pan from the drilled retaining stud.

The timing gears and governor are lubricated by oil thrown from the front bearings of the camshaft and crankshaft, and from the idler gear stud.

Oil Pump



The gear type oil pump is located at the rear end of the camshaft outside the crankcase behind the flywheel. The pump draws oil through a drilling in the crankcase and the intake pipe from the oil intake screen. Clean this screen each time the oil pan is removed. The connection between the oil intake pipe and the crankcase must be air tight.

A 1/8-inch pipe plug, located at the rear left side of the crankcase near the top of the flywheel housing, gives access to the pump for priming. This priming should only be necessary when the pump has been assembled dry or after long periods of storage, where the pump may have drained completely.

The oil pressure indicator shows whether the oil pump is working, when the system is correctly filled. At idle speed or above the indicator needle should register. If the needle does not register stop the engine and determine the reason.

Pressure Regulator Valve

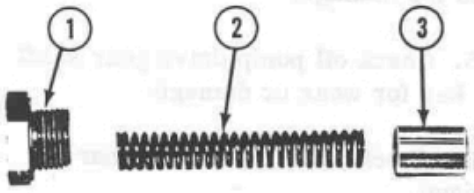
Since the normal output of the oil pump is much greater than the normal requirement of the engine lubricating system, and all the oil cannot escape through the engine bearing clearances and metered passages, a spring-loaded regulator valve is employed to release the excess oil. This valve maintains an operating oil pressure of 30 - 35 lbs. at 1800 rpm.

The piston-type pressure regulator valve and spring is located behind the hex-head retaining plug on the right side of the crankcase, near the timing gear end. The valve should slide freely in the crankcase bore and the spring should be straight so that the valve will not be cocked in the bore or on its seat.

The free length of the valve spring will give some indication of its condition. However, the best test to determine the spring's tension is to load it with the weight specified, and measure its length at that load. If this tension test is found below specifications the spring should be replaced or low oil pressure will continue.

During a complete engine overhaul, while the engine is completely disassembled, all oil passages should be cleaned, using brass rifle brushes. Also, if crankshaft or connecting rod bearings have failed due to abrasives in the lubricating oil, the engine must be completely disassembled and thoroughly cleaned. Clean all lubricating oil passages, using rifle brushes and compressed air. Clean and inspect the oil pump and pressure regulator assembly and service them as required.

Removal and Disassembly



FESM-3278

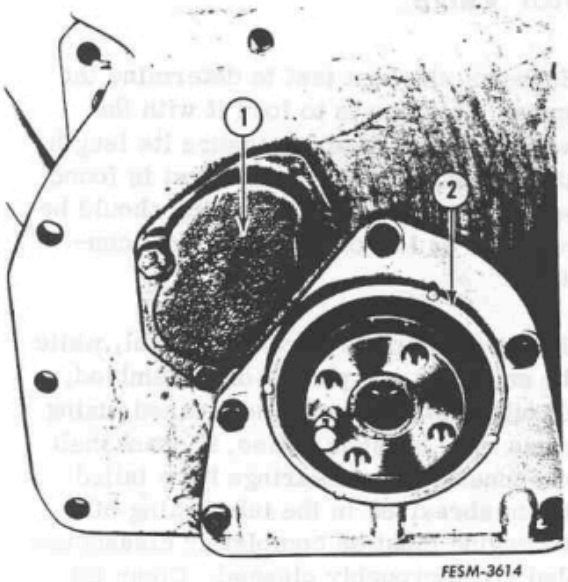
1. Plug
2. Spring
3. Valve

If oil pressure is not within specifications, the oil filter regulator valve, intake pipe with screen, and the pump may be disassembled as follows:

1. Remove filter element and clean filter case. If filter case is exceptionally sludgy, install bolt without cover and flush thoroughly.

2. Remove hex-head regulator valve retaining plug and remove the spring and valve.

3. Remove the crankcase oil pan. Remove the oil intake pipe and screen.



4. Remove the engine. Refer to page 1-10.

5. Remove the flywheel.

6. Remove the oil pump body and pump gears.

1. Oil pump body
2. Rear seal and retainer assembly

Inspection and Servicing

1. Clean regulator valve assembly and valve bore.

2. Check condition and tension of regulator valve spring. If spring is bent or rusted or the tension is not within specifications it should be replaced.

3. Check regulator valve to make sure it slides freely in its bore.

4. Thoroughly clean oil intake pipe and screen. Check screen and connections for damage.

5. Check oil pump drive gear shaft and key for wear or damage.

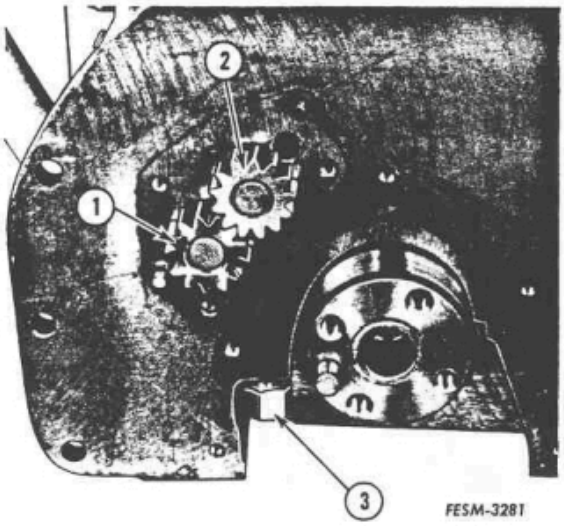
6. Check pump gears for wear or damage.

7. Check pump body for wear or damage.

8. Clean crankcase breather.

9. Clean oil passages in crankcase with a round, bristle type or brass rifle brush.

Reassembly



1. Drive gear
2. Idler gear
3. Oil intake pipe connection

1. Install new filter element along with cover and drain plug.

2. Install regulator valve, spring and retainer, using new retainer gasket.

3. Install oil intake pipe and screen.

4. Install crankcase pan, using new gasket.

5. Install oil pump gears.

6. Install pump body, using new gasket.

7. Install the flywheel and secure with the four cap screws. Tighten cap screws to 45 ft. lbs. torque.

8. Install the engine in the tractor. Refer to page 1-12.

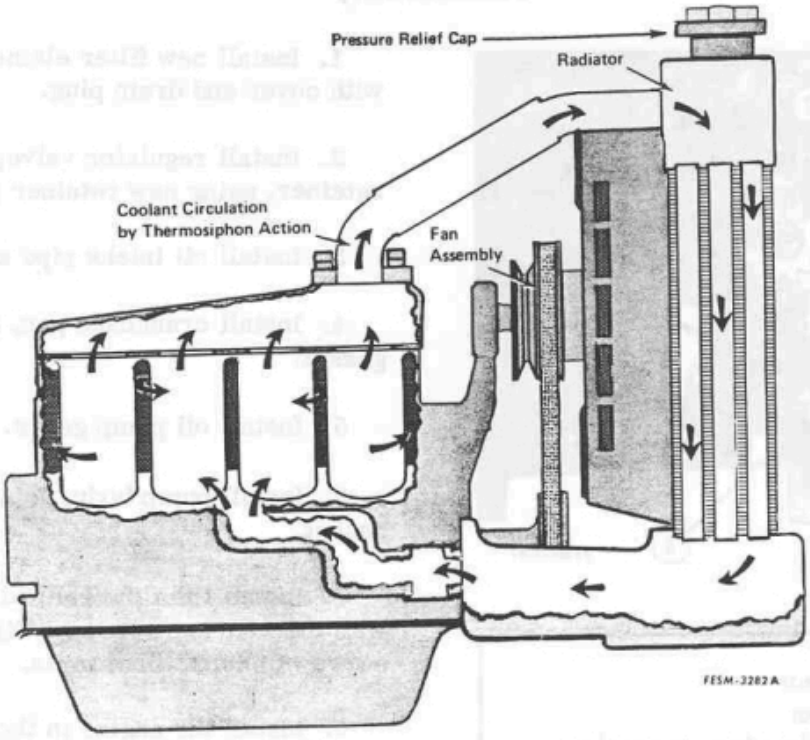
9. Fill crankcase with proper amount of specified oil.

10. Prime oil pump, start engine and check oil pressure.

11. Recheck crankcase oil level.

COOLING SYSTEM

General Description and Operation



Water or an antifreeze solution circulates through the engine block and radiator by thermosiphon action. As the water in the engine becomes heated, it moves upward and enters the radiator at the top. The water is cooled by the air blast drawn between the radiator tubes by the fan. The cooled water moves to the bottom of the radiator and back into the engine block to replace the heated water passing out at the top. This creates a circulation in the system.

The radiator is the flat-tube type and is enclosed in a grill. The cooling fan is equipped with a shroud which greatly increases its efficiency. A drain plug, located in the bottom of the steering gear housing base, permits the entire cooling system to be easily emptied.

CAUTION: Work should not be done on the cooling system while the system is hot or near operating temperature.

NOTE: Effective with tractor chassis serial number U248125 and above is the new Roto-Safe pressure cap. The new pressure cap has a pressure relief twist top for safer removal when the cooling system is hot.

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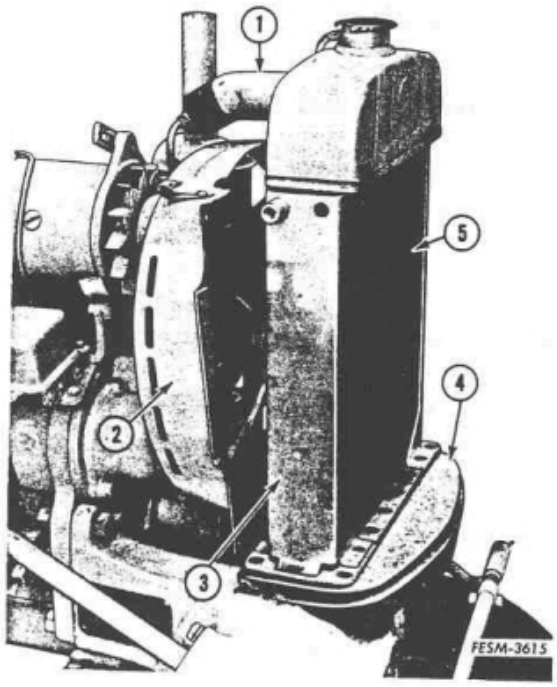
Removal of Radiator Assembly

1. Remove the pipe plug located in the bottom of the steering gear housing and drain the coolant.

2. Disconnect the ground wire from the battery and the wires to the headlights.



3. Shut off fuel at the fuel strainer and disconnect the fuel line. Remove the headlights and the hood and fuel tank assembly.

4. Remove the radiator grille assembly.

5. Disconnect the top hose from the radiator elbow (1).

6. Remove the screws securing the fan housing (2) to the radiator.

7. Move the fan housing (2) out of the way, and remove the cap screws securing the radiator (5) to the steering gear housing (4).

8. Remove the radiator side channels (3) and remove the radiator assembly from the tractor.

1. Radiator elbow
2. Fan housing
3. Side channel
4. Steering gear housing
5. Radiator assembly

Inspection and Repair

During servicing or repair procedures, inspection of parts and assemblies involved is always an important responsibility of the serviceman. Generally, inspection is performed after disassembly has been completed, however, in many cases, time can be saved by inspecting parts when they are being removed.

Be sure to check the following items and perform the servicing or repair that is indicated.

1. Inspect the radiator for accumulation of rust or leaks and flush out passages in the engine.

2. Check all hoses and if badly cracked, or dry and hard, they should be replaced.

3. Overheating is often caused by bent or clogged radiator fins. If the spaces between the fins are clogged, clean them out with compressed air or water. Avoid poking into the spaces with any hard object.

4. If fins are bent, they should be straightened, but be careful not to damage the tubes or break the bond between the fins and the tubes. Check carefully for possible leaks after completing this work and before completely reassembling the radiator.

5. Inspect radiator passages for clogging. If this condition is found, the passages should be cleaned at a qualified radiator service station.

CAUTION: Never use chemical mixtures to stop radiator leaks except as a temporary or emergency procedure. It should then be followed by correct servicing at an early date.

Installation of Radiator Assembly

1. Using a new gasket, install the radiator assembly on the steering gear housing.

2. Install the hold down plates and the side channels. Tighten the cap screws to 20 ft. lbs. torque.

3. Install the fan housing on the radiator.

4. Connect the water outlet hose.

5. Install the radiator grille assembly.

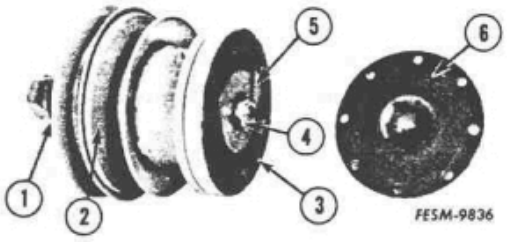
6. Install the hood and fuel tank and the headlights. Connect the fuel line to the fuel strainer.

7. Connect the wires to the headlights and the ground wire to the battery.

8. Install the pipe plug in the bottom of the steering gear housing, and fill the radiator with coolant.

Cooling Fan Service

Removal and Disassembly



1. Spindle
2. Hub assembly
3. Bearing assembly
4. Lock nut
5. Impeller
6. Bearing cap

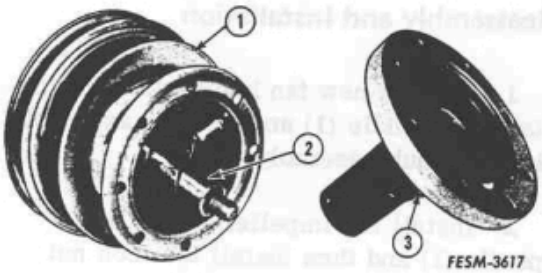
1. Remove the headlights and the hood and fuel tank.

2. Loosen the tension on the generator drive belt and move the belt out of the pulleys.

3. Disconnect and remove the water outlet elbow and hose.

4. Remove the air cleaner assembly from the engine.

5. Remove the screws securing the fan housing to the radiator.



1. Hub assembly
2. Spindle
3. Bearing

6. Loosen the nut securing the spindle to the crankcase front cover, and remove the cooling fan assembly from the tractor.

7. Remove the fan blade from the fan assembly.

8. Remove the fan bearing cap (6).

9. Remove the lock nut (4) and the impeller (5) from the spindle. Note the position of the impeller for proper reassembly.

10. Remove the bearing (3) from the spindle and hub.

11. Remove the spindle (2) from the hub assembly (1).

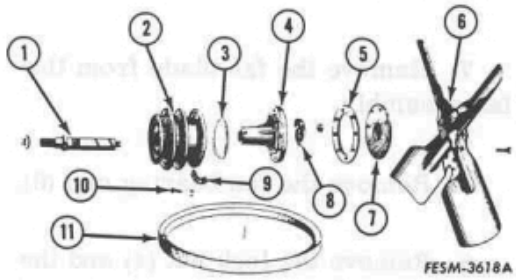
Inspection and Repair

1. Check the spindle, bearing and hub for wear or side play between them.

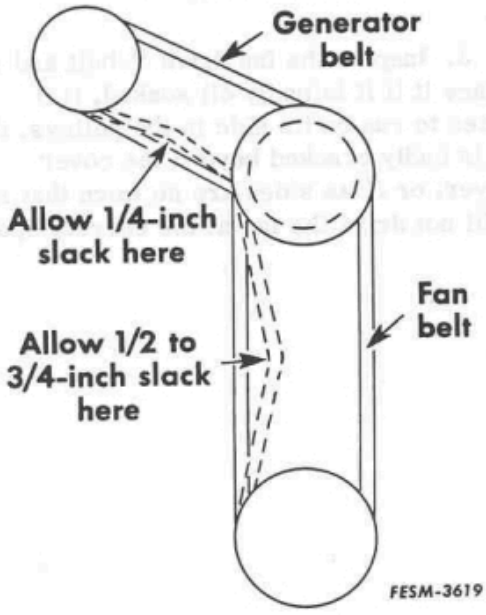
NOTE: The assembled fan hub assembly should have a slight amount of end play on the spindle and should turn freely without noticeable drag.

2. Check the fan drive pulley which is a press fit on the engine crankshaft. If there is looseness, check for wear of the key and in the hub. Replace parts as necessary to obtain a tight fit.

3. Inspect the fan drive V-belt and replace it if it is badly oil soaked, if it tries to run on its side in the pulleys, if it is badly cracked beyond the cover layer, or if its sides are so worn that it will not drive the fan at the correct speed.



1. Spindle
2. Hub assembly
3. Fan hub gasket
4. Fan bearing
5. Fan bearing gasket
6. Fan
7. Fan bearing cap
8. Oil impeller
9. Double nut
10. Oil retaining screw
11. Fan belt



Reassembly and Installation

1. Using a new fan hub gasket (3), install the spindle (1) and bearing assembly (4) in the hub assembly (2).

2. Install the impeller (8) on the spindle (1) and then install the lock nut and tighten to 20 ft. lbs. torque.

3. Install the fan bearing cap (7) using a new gasket(5).

4. Install the fan blade (6) and secure with the cap screws and double nuts (9).

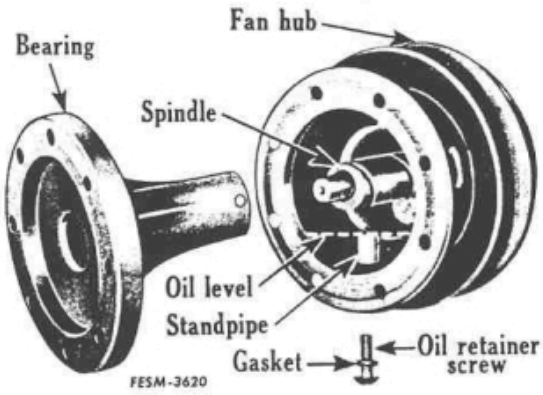
5. Install the fan assembly and belts on the crankcase front cover. Do not tighten the belts at this time.

6. Install the screws securing the fan housing to the radiator.

7. Install the air cleaner on the engine.

8. Install and connect the water outlet elbow and hose.

9. Adjust the tension on the fan drive and generator belts to allow 1/2 to 3/4 inch slack on the fan drive belt and 1/4 inch slack on the generator belt as shown.



10. Turn the fan hub so the oil retainer screw is at a right, horizontal position. Remove the screw and fill the hub with lubricant. (Refer to Operator's Manual.)

11. Turn the filler hole to the bottom position and let excess oil drain out.

This filler hole has a stud on the inside which controls the level of oil to be held in the hub. When oil stops running out, replace the retaining screw.

12. Install the hood and fuel tank. Connect the fuel line to the fuel strainer. Install and connect the headlights.

TROUBLE SHOOTING

If a specific problem and remedy is not covered herein, proceed to isolate the system in which the problem occurs and then locate the defective component. The greater the number of symptoms of problems that can be evaluated the easier will be the isolation of the defect.

Much can be learned about the condition of an engine if a good visual inspection is performed before the actual cleaning operations are begun. Many engine parts give external evidence of some failure or defect which can be looked for when the engine is later disassembled. For example, a heavy accumulation of oil or grease at some spot might indicate a leaking seal or gasket; or, excessive rust and other corrosion at another place might well mean leaks in the cooling system.

If an engine can be operated, unusual noises also help determine what defects to look for. However, before engine disassembly is started, the outer surface should always be given a thorough cleaning. Methods used will depend on the facilities available or other local conditions. The dry steam method is recommended since this is both fast and effective. After steam cleaning, the engine should be wiped dry with a clean cloth to minimize possible rusting. After cleaning, the exterior of the engine should once more be inspected carefully and a note made of any parts such as brackets, covers, bolts, etc., that are bent, broken, rusted or missing completely. The crankcase or cylinder block should be checked for evidence of freezing around core plugs or for actual breaks in the water jacket.

Probable Cause	Remedy
Engine Will Not Turn Over	
1. Cranking motor inoperative or defective	Replace.
2. Battery faulty	Replace Battery.
3. Cables and terminals faulty	Inspect ground cable and battery-to-starting switch cable for any faults which may cause shorting; also inspect for incorrect connections. Replace cables if necessary.
4. Starting switch defective	Replace starting switch.
5. Internal seizure	Hand crank engine with spark plugs removed and clutch disengaged. If engine does not turn easily, internal damage is indicated.
Engine Turns But Will Not Start	
1. Fuel system faulty	
(a) No fuel in tank	Fill tank with fuel.
(b) Fuel strainer bowl screen clogged	Clean bowl and screen.
(c) Water in gasoline	Drain gasoline tank, gasoline strainer and carburetor. Refill with clean gasoline.
(d) No gasoline at carburetor	Clean fuel line from tank to carburetor. Clean fuel inlet screen in carburetor. Check for clogged vent holes in fuel tank cap.
2. Battery charge low and does not turn engine fast enough	Charge or replace battery.
3. Ignition system faulty.	
(a) Broken distributor rotor	Replace rotor.
(b) Moisture in the distributor	Remove cap and rotor and dry off. Use compressed air to remove moisture from distributor.

Probable Cause	Remedy
Engine Turns But Will Not Start - Continued	
3. Ignition system faulty - Continued	
(c) Condenser shorted or open	Replace condenser.
(d) Broken distributor cap	Replace cap.
(e) Excessively pitted distributor cap contact terminals	Clean contact terminals with fine sandpaper. Blow all sand out of cap before reinstalling.
(f) Points not properly adjusted	Readjust points. Refer to "Tune-Up", page 1-74.
(g) Short or open circuit in distributor	Correct or replace.
(h) Ignition circuit broken	Check cable from distributor cap-to-ignition coil and check spark plugs for correct wiring or loose connections.
(i) Wet or fouled spark plugs	Remove spark plugs, wipe off moisture and dry plugs. Remove carbon. Reset plug gap; refer to "Tune-Up", page 1-74.
(j) Cracked or broken spark plug insulators	Replace spark plugs.
(k) Ignition switch inoperative	Place a jumper wire across the two ignition switch terminals on the back of the switch. Attempt to start the engine. If engine starts, the switch is inoperative and must be replaced.
4. Carburetor choked too much	Open the choke. Wait a few minutes before attempting again to start engine.
5. Air intake restricted or exhaust clogged	Service the air cleaner and clean exhaust system.

Probable Cause	Remedy
Missing and Backfiring But Fails to Start	
1. Water in gasoline	Drain fuel tank, fuel bowl and carburetor. Refill with clean gasoline.
2. Air leaks around intake manifold	Tighten manifold stud nuts. Replace gasket if necessary.
3. Improper firing order	Check spark plug cables for correct installation at spark plugs and distributor cap.
4. Distributor not correctly timed to engine	Check and adjust timing. Refer to "Tune-Up", page 1-74.
5. Moisture in the distributor	Remove cap and rotor and dry thoroughly.
6. Distributor cap shorting out	Check for loose contact terminals or dirt in cracked cap.
Missing or Cutting Out at High Speed	
1. Distributor Breaker Plate not grounded properly	Check ground lead wire and screws.
2. Primary lead not tightened or partially broken	Check primary lead wire and screws.
3. Weak point spring tension	Adjust point spring tension or replace points.
4. Spark plugs faulty	Check plug gap. Refer to "Tune-Up", page 1-74 for correct gap. Replace plugs if necessary.
5. Point gap incorrect	Readjust point gap. Refer to "Tune-Up", page 1-74.
6. Low voltage to spark plugs caused by defective coil	Replace coil.
7. Carburetor	
(a) Float level set too low	Check float level. Reset if necessary.
(b) Dirt in main jet	Clean out main jet. Replace if necessary.
(c) Restriction in filter	Clean out fuel inlet filter in carburetor.

Probable Cause	Remedy
Missing or Cutting Out at High Speed - Continued	
8. Poor compression:	
(a) Head gasket leaks	Replace head gasket.
(b) Burned valves	Grind valves.
(c) Worn piston rings	Replace piston rings.
Excessive Pinging - Detonation	
1. Distributor	
(a) Point gap incorrect	Readjust point gap. Refer to "Tune-Up", page 1-74.
(b) Spark advanced too far	Check and adjust timing. Refer to "Tune-Up", page 1-74.
(c) Fouled spark plugs	Clean plugs and reset the gap. Refer to "Tune-Up", page 1-74.
2. Carburetor	
(a) Main metering system too lean	Adjust carburetor. Refer to "Fuel System", Section 2.
(b) Float level set too low	Check float level and reset if necessary.
3. Cylinder head not bolted down tight	Torque cylinder head bolts. Refer to page 1-14 for tightening sequence.
Engine Does Not Operate Smoothly	
1. Pitted distributor points	Clean and readjust points or replace points.
2. Cracked distributor cap	Replace.
3. Worn or bent distributor shaft	Replace.
4. Worn breaker plate hub	Replace breaker plate assembly.
5. Worn distributor cam	Replace.
6. Improper point spring tension	Adjust point spring tension or replace points.

Probable Cause	Remedy
Engine Does Not Develop Full Power	
1. Distributor: (a) Point gap incorrect	Readjust point gap. Refer to "Tune-Up", page 1-74.
(b) Ignition timing incorrect	Check and adjust timing. Refer to "Tune-Up", page 1-74.
2. Low voltage to spark plugs caused by defective coil	Replace coil.
3. Fouled spark plugs	Clean plugs and reset the gap. Refer to "Tune-Up", page 1-74.
4. Carburetor: (a) Float level set too low	Check float level. Reset if necessary.
(b) Choke plates partially restricted	Reposition choke control linkage.
(c) Restricted throttle linkage	Repair or replace.
5. Insufficient air to engine	Service the air cleaner.
6. Late valve timing	Check and adjust timing. Refer to "Specifications."
7. Air leaks around intake manifold	Tighten manifold or install new gasket if necessary.
8. Exhaust restricted	Remove restriction.
9. Lack of compression	See "Lack of Compression" in this chart.
10. Governor worn out or out of adjustment	Refer to governor section of "Fuel System", Section 2.

Probable Cause	Remedy
Loss of Oil Pressure	
1. Low lubricating oil level	Add sufficient oil to bring level up to specified mark on level gauge.
2. Clogged oil filter	Change filter element.
3. Oil leaks	See "Excessive Lubricating Oil Consumption" in this chart.
4. Engine oil pressure indicator or line defective	Replace.
5. Worn main, connecting rod or camshaft bearings	Replace.
6. Dirt in oil filter relief valve or relief valve spring broken	Clean valve or replace spring.
7. Oil pump worn	Repair or replace.
8. Oil diluted or not as specified	Change oil regularly using correct grade specified in Operator's Manual.
Lack of Compression	
1. Valves sticking	Clean valve guides and stems. Grind valves if needed.
2. Worn pistons, rings and cylinder walls	Replace pistons, rings and cylinder sleeves.
3. Defective cylinder head gasket	Replace.
4. Broken valve spring	Replace.
Smoky Exhaust	
1. Engine overload	Reduce load.
2. Incorrect grade lubricating oil	Use grade of oil specified in Operator's Manual.

Probable Cause	Remedy
Smoky Exhaust - Continued	
3. Worn valve guides, valve stems, pistons and sticky or worn oil control rings	Repair or replace.
4. Distributor not properly timed	Check and adjust timing. Refer to "Tune-Up", page 1-74.
5. Choke not fully open	Open choke fully.
Excessive Lubricating Oil Consumption	
1. Oil leaks	Check and service where necessary; valve covers, tappet cover plate, crankcase front cover, oil seals at front and rear of crankshaft, oil pan plug, gasket, oil filter and oil pressure indicator tube.
2. Worn valve guides, piston rings, pistons and clogged oil control rings	Replace worn parts.
3. Incorrect grade of lubricating oil	Use grade of lubricating oil specified in Operator's Manual.
4. Over-heated engine	Refer to "Engine Overheats" in this chart.
5. Excessive oil poured into crankcase . .	Drain oil. Add amount specified in Operator's Manual.
Excessive Fuel Consumption	
1. Distributor:	
(a) Point gap incorrect	Readjust point gap. Refer to "Tune-Up", page 1-74.
(b) Ignition timing incorrect	Check and adjust timing. Refer to "Tune-Up", page 1-74.
2. Low voltage to spark plugs caused by defective coil	Replace coil.
3. Worn or fouled spark plugs	Clean plugs and reset the gap. Refer to "Tune-Up", page 1-74 for correct plug gap setting.

Probable Cause	Remedy
Excessive Fuel Consumption - Continued	
4. Carburetor:	
(a) Float level set too high	Check float level and reset if necessary.
(b) Leaking needle or seat	Repair or replace.
(c) Choke plate not fully open	Reposition choke control linkage.
5. Restriction in air cleaner	Service the air cleaner.
Engine Noises	
1. Loose piston pin. A sharp rap at idling speed. The pin at fault can be found by short circuiting the spark plugs, one at a time, until the noise stops	Repair or replace.
2. A flat slap, when advancing engine speed under load, indicates a loose piston	Replace piston.
3. A metallic knock when idling and retarding engine speed, but disappears under load indicates worn or loose connecting rod bearings. The bearing at fault can be located by short circuiting the spark plugs one at a time. The noise will disappear when the cylinder with the defective bearing is short circuited	Replace worn bearings.
Bearing Failure	
1. Low oil pressure	Refer to problem "Loss of Oil Pressure."
2. Lack of oil	Maintain proper oil level. Check for leaks.
3. Engine runs too hot	Keep engine at normal operating temperature.

Probable Cause	Remedy
Bearing Failure - Continued	
4. Loose bearings	Install new bearings.
5. Improper lubricating oil	Use a suitable oil of non-corrosive type, correct grade and viscosity.
6. Foreign materials entering engine	Use clean oil containers when filling engine with oil and see that all gaskets on the engine are in good condition.
7. Oil lines clogged	Clean all oil passages.
8. Connecting rod bent	Align or install new connecting rod.
9. Crankshaft out of alignment	Straighten or install new shaft.
Valves Sticking	
1. Valve springs weak or broken	Install new springs.
2. Gummy deposits from inferior fuel or oil	Clean and use proper fuel or oil.
3. Valve stems scored or carboned	Clean. Install new valves if necessary.
4. Insufficient clearance between valve stem and guide	Ream guides for proper clearance.
Overheating Due to Restricted Air Flow	
1. Bent fan blades	Straighten and correct pitch of fan blades.
2. Trash between radiator fins	Clean out thoroughly between radiator fins. Use compressed air.
3. Bent radiator fins	Straighten bent fins.
4. Fan housing damaged or missing	Repair or install new fan housing.

Probable Cause	Remedy
Overheating Due to Poor Condition	
1. Restrictions in radiator core or engine water jacket	Drain system. Disconnect hoses and reverse flush the radiator and block.
2. Low coolant level	Fill cooling system to proper level. Check for leaks.
3. Pressure cap loose - coolant escaping	Tighten pressure cap.
4. Fan belt slipping or loose	Tighten if loose. Replace belt if greasy, worn or damaged.
Overheating Due to External Leakage	
1. Defective hoses or connections	Replace defective hoses. Check clamps for fatigue and replace as required.
2. Radiator leaks	Remove radiator. Test for leaks and solder.
3. Damaged gaskets	Check for leaks around water inlet and outlet elbows and cylinder head. Replace defective gaskets.
4. Cracked or warped cylinder head	Replace cylinder head and gasket.
5. Cracked cylinder block	Replace cylinder block.
6. Defective water inlet or outlet elbow . . .	Replace.
Overheating Due to Internal Leakage	
1. Warped cylinder head	Replace cylinder head and gasket.
2. Blown cylinder head gasket	Replace gasket. (Check crankcase oil for presence of water.)

Probable Cause	Remedy
Overheating Due to Internal Leakage - Continued	
3. Cylinder head cap screws not properly torqued	Torque head cap screws. Refer to page 1-14.
4. Cracked cylinder wall	Replace cylinder block.

TUNE-UP

The following steps outline the operations which should be followed in an engine tune-up. These steps point out the various parts of the engine to be checked, cleaned, timed or repaired, as needed. For detailed information on the repair and adjustment of the components of the respective Systems, Fuel and Electrical refer to "Fuel System" Section 2 and "Electrical System" Section 9.

1. Check the throttle control.

(a) Check the operation of the control.

(b) Check the operation of the springs on the governor control rod.

(c) Check the rpm of the engine, using a tachometer.

2. Check the clearance on intake and exhaust valves and make adjustments if necessary. (Refer to "Valve Clearance Adjustments", page 1-15.)

3. Check the air cleaner and connections for possible leaks. Refer to the Operator's Manual.

4. Replace the lubricating oil filter element and clean the filter case assembly thoroughly.

5. Remove the fuel strainer bowl and clean thoroughly.

6. Flush the radiator with clean water, then drain and refill with soft water if available, or anti-freeze solution in cold weather.

7. Check the fan belt for wear and correct tension. Replace if necessary.

8. Check the distributor points, cap and condenser. Replace necessary parts and reset point gap to .020 inch.

9. Check the spark plugs. Replace broken plugs and clean and reset all plugs to be reinstalled. Set gap at .023 inch.

10. Check the ignition coil and the primary wires and be sure the connections are clean and tight. A few broken wire strands on an otherwise sound connection will still result in difficult starting and improper engine performance.

11. Check all electrical connections in both the high and low tension circuits of the ignition system.

12. Check all switches.

13. Remove and clean the carburetor inlet screen.

14. Remove the fuel bowl and check the float level. Adjust if necessary.

15. Check the float valve assembly for leakage.

16. Inspect the generator and cranking motor commutators and clean.

17. Check the ignition timing and correct if necessary. Set timing at 16^{o} before T.D.C. at high idle.

18. Check the compression pressures. Refer to "Specifications".

Section 2

FUEL SYSTEM

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Carburetor Operation	2-3
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Specifications

Carburetor

Part number	251 234 R94	364 579 R91	71 523 C91
Type	Up draft	Up draft	Up draft
Model and size	IH - 3/4	IH - 3/4	Zenith
Liquid level - inch	9/16 - 5/8	9/16 - 5/8	15/32
Float height - inches	1-13/32	1-13/32	1-5/32
Float drop - inch	3/16	3/16	3/16
Bleed	57**	53**	#34*
Main metering jet size	.034	.032	#21*
Idle jet	75**	75**	#12*
Discharge nozzle	52**	39**	#50*
Venturi	15/32	15/32	15mm
Needle valve seat	52**	52**	#35*
Choke	Butterfly valve (manual control)	Butterfly valve (manual control)	Butterfly valve (manual control)

* Zenith designation number (not drill size)
** Drill size

Governor

Engine rpm	Eng. Ser. No. U312389 and below	Eng. Ser. No. U312390 and above
Low idle ± 25	475	475
High idle ± 25	2000	2080
Rated load ± 10	1800	1900

Governor Spring	Eng. Ser. No. U312389 and below	Eng. Ser. No. U312390 and above
Outside diameter - inch	.625	.735
Free length - inches	1-1/2	1-3/8
Test length - inches	1-7/8	1-59/64
Test load - pounds	29.8	39.1

Bumper spring

Free length - inch	7/8
Test length - inch	5/8
Test load - pounds	10.5

Governor weight to pin clearance - inch ..... .001 - .004

Carburetor

GENERAL DESCRIPTION

The fuel system consists, basically, of a fuel supply tank, fuel shut-off valve, fuel strainer, carburetor, intake-exhaust manifold, air cleaner and a variable speed governor.

Liquid fuel flows from the supply tank by gravity through the fuel strainer and sediment bulb to the carburetor. Air enters these naturally aspirated systems through the air cleaner, where dirt and abrasive material are removed.

Clean air and fuel is metered to the engine by the carburetor; in varying proportions to meet the changing demands of load and speed. The variable speed governor controls the carburetor throttle to admit a greater or lesser volume of air-fuel mixture. This supports the operator's demand for engine speed, and provides power to maintain that speed, up to the capacity of the engine.

The operation, inspection, repair and adjustment of the various parts of the fuel system are covered in the following divisions of this service manual section, under appropriate major headings.

CARBURETOR OPERATION

The function of the carburetor is to meter the required amount of fuel to meet varying demands of engine load and speed, and to discharge this fuel into the intake air stream in as fine a spray as possible.

The air-fuel ratio is not constant for all loads and speeds. Idle and low speeds require rich fuel mixture; full load, full speed operation requires the leanest fuel mixture. The modern carburetor with its air-bleed-well method of compensation, will give these proportionate air-fuel mixtures to meet load-speed demands, resulting in smooth, economical engine performance. To simplify the explanation of how the carburetor functions, we will divide it into four systems and discuss each, separately.

- FUEL SUPPLY SYSTEM
- IDLING SYSTEM
- LOAD SYSTEM
- STARTING SYSTEM

Fuel Supply System

The fuel supply system is that portion of the carburetor consisting of the fuel inlet strainer, fuel needle valve and seat, fuel float, fuel bowl and the bowl air vent.

The function of the float and fuel needle valve is to maintain an even level of fuel in the bowl. The float assembly consists of a float-body soldered to a float lever. This assembly hinges on the float axle supported by a bracket on the bowl cover. Fuel from the supply tank enters the bowl through the inlet strainer and the float needle valve. As the level of fuel rises in the bowl, the float is carried upward until the float lever forces the needle valve against its seat, stopping further inflow of fuel.

While the engine is in operation, fuel flows from the bowl through the main metering jet to the load system or idling system and the float valve maintains just enough opening to sustain a constant level of fuel in the bowl.

The bowl air vent passage is a drilling in the throttle body connecting the float chamber with an air vent channel surrounding the venturi. Air for the bowl vent, the well bleed and the idling system is taken from this channel in the venturi which, in turn, is vented to the carburetor main air intake. In this manner, all air taken into the carburetor is supplied through the air cleaner. This not only prevents entry of dirt and abrasives, but creates what is called a "balanced" vent.

The ratio of air and fuel mixture from a "balanced" carburetor will not be seriously affected by changes in condition of the air cleaner as it becomes restricted by accumulation of dirt. A balanced type carburetor must have an airtight seal between the bowl and the bowl cover, since any air admitted into the bowl other than through the calibrated vent, will upset the ratio of air-fuel delivery and also allow entry of dirt.

In review, sustained constant level of fuel in the bowl, together with controlled venting of the bowl, insures a stable supply of fuel to the various metering systems and is unaffected by the height of fuel in the supply tank or normal operating changes in air cleaner condition.

Idling System

The idling system consists of an idle discharge port, idle adjusting needle, idle jet and the connecting channels and air bleed. This system controls the mixture at partially opened throttle for idle and slow engine speeds, until the throttle is opened sufficiently to allow the load system to function.

Fuel for the idling system enters the well through the main metering jet and is drawn through the idle jet calibration into the idle passage where it is mixed with air from the idle air bleed. The air-fuel mixture enters the air stream past the throttle plate, from the idle discharge port. The idle air adjusting screw on the carburetor is turned toward the seat to enrich the air-fuel mixture.

Load System

The load system consists of the venturi, discharge nozzle, well, well air bleed, and main metering jet. The load system as the name implies, controls the air-fuel mixture during the time the engine is loaded or is operating above idle speed.

When the throttle plate is opened a short distance beyond the idle port, a sufficient amount and velocity of air passes the venturi and the discharge nozzle to draw fuel from this source. This condition starts the load system functioning. Within a partial load-speed range of throttle plate movement, both the idling system and load system are delivering fuel. Further opening of the throttle plate, due to increased engine load-speed results in diminished delivery of fuel from the idling system. Ultimately, all delivery of fuel from the idling system is stopped and air is being drawn from this source into the well.

The main metering jet has a calibrated opening large enough to permit the flow of the maximum amount of fuel necessary for full load operation. When the engine is stopped or idling, the level of fuel in the well and discharge nozzle is similar to the level in the fuel bowl. As the load system goes into operation with increased load and throttle opening, the fuel is drawn from the discharge nozzle at a higher rate than supplied to the well by the main metering jet. This lowers the level of fuel in the

well. As the load and throttle opening is increased, the fuel level in the metering well drops below a series of "A" air bleed holes in the discharge nozzle, admitting an increasing amount of air from the well air bleed. This metered addition of air to the discharge nozzle is necessary to compensate for the fact that the partial vacuum produced at the nozzle increases out of proportion with the increased velocity of air through the venturi. Were it not for this well-air-bleed compensation, the proportion of fuel to air would rapidly increase with the throttle opening, producing an extremely "rich" mixture at full throttle, full load operation.

A small additional amount of fuel is necessary to insure prompt response for engine acceleration. When the throttle is suddenly opened, the resulting rush of air through the venturi picks up this necessary extra fuel which remains above the main metering jet in the metering well during part throttle operation.

Starting System

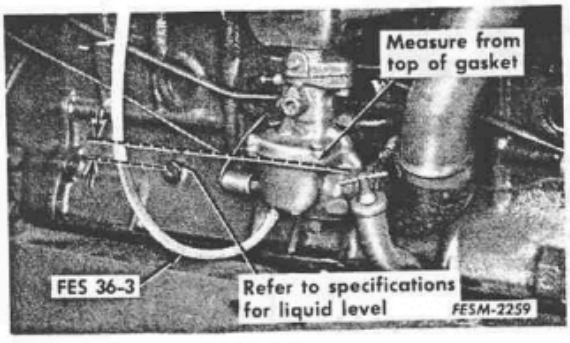
The starting system consists of a manually operated choke valve mounted in the carburetor main air intake. When the choke valve plate is turned to the closed position, it restricts the air entering the carburetor. It does not, however, restrict the main air vent passage. This upsets the balance of the carburetor, allowing the increased suction to draw strongly upon the fuel discharge openings when starting the engine.

When the outside air, manifold, and engine combustion chambers are cold, it is necessary to supply a very "rich" starting mixture. Only the "lighter-ends" or more volatile portions of the fuel can be vaporized because of the low temperature and the slow movement of air past the discharge nozzle due to low cranking speed. The necessary large quantity of fuel is supplied by closing the choke valve during the cranking period. As the engine gathers speed and warms up, the choke valve is manually opened to lean out the air-fuel ratio to a normal mixture.

An opening is provided in the bottom of the carburetor main air intake to drain off any excess unvaporized fuel which may return from the manifold. This opening is protected against the entry of dust and abrasives by a felt filler. Should this filler shrink and deteriorate from age, dirt may be drawn into the engine contributing to excessive engine wear. Should this opening be painted over or otherwise plugged, no drainage is possible and flooding with raw fuel can occur if the fuel float valve leaks.

LIQUID LEVEL CHECK
(Carburetor on Engine)

The liquid level in the carburetor can be checked with the carburetor on the engine using tool FES 36-3.



1. Close the fuel shut-off at the fuel tank.

2. Remove the drain plug at the bottom of the carburetor. Attach the tool FES 36-3 as shown.

3. Open the fuel shut-off. Fuel will flow into the tube and seek the same level as the liquid level in the carburetor.

4. Measure the distance between fuel level in the tube to the top of the fuel bowl gasket. This will be the liquid level in the carburetor. Refer to specification for specified liquid level.

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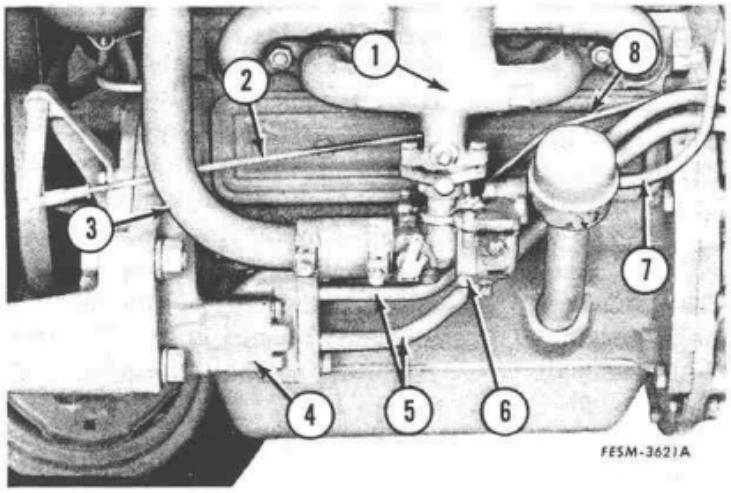
Removal and Installation of Carburetor

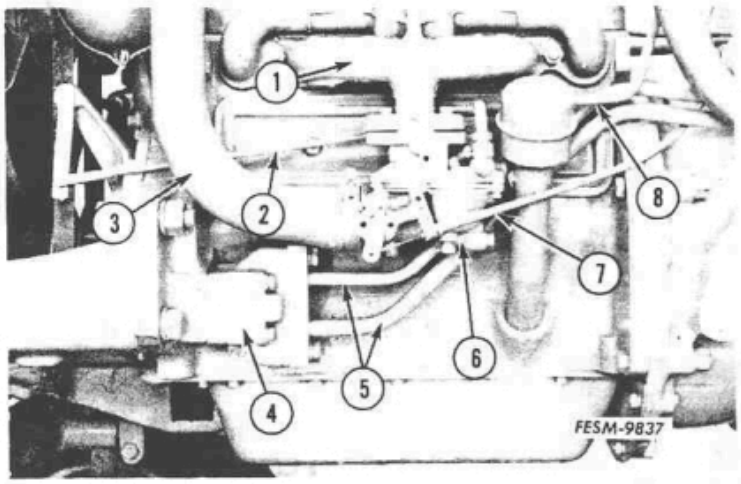
Before removing the carburetor from the engine for cleaning, inspection or repair, clean the area and various connecting points to prevent entry of dirt into those parts which remain with the engine.

Failure to perform this simple operation may result in an ultimate condition much worse than that which made the carburetor removal necessary.



Engine Ser. No. U312389 and below

1. Intake and exhaust manifold
2. Governor connecting rod
3. Air cleaner pipe
4. Touch-Control pump
5. Manifold tubes
6. Carburetor
7. Fuel line
8. Choke control rod



Engine Ser. No. U312390 and above

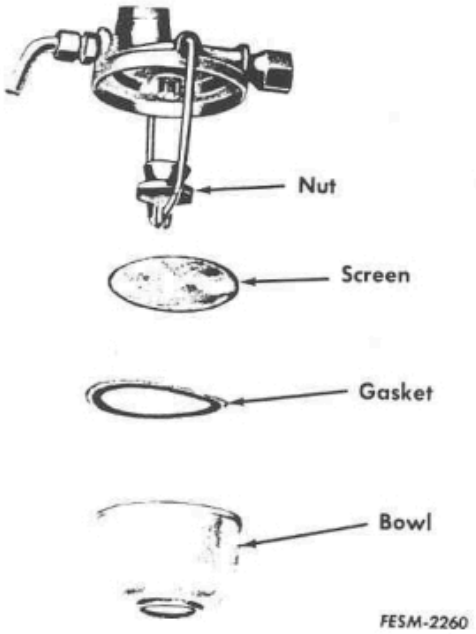
1. Intake and exhaust manifold
2. Governor connecting rod
3. Air cleaner pipe
4. Touch-Control pump
5. Manifold tubes
6. Carburetor
7. Choke control cable
8. Fuel line

After the carburetor is removed, inspect the air cleaner pipe and hose for possible air leaks wherein dirt and abrasives could enter the engine. Discard the carburetor flange gasket. Clean manifold flange of any scraps of old gasket which may adhere and would prevent sealing of new gasket.

When reinstalling the carburetor, care must be used in securing air and dust tight connections of air cleaner pipe and hose. Renew if necessary. Before reconnecting the fuel line to the carburetor, remove and clean sediment bowl and screen. Use new bowl gasket in replacing sediment bowl. Open the fuel tank valve momentarily to flush line and observe for free flow of fuel.

After the carburetor is reinstalled on the manifold, recheck the adjustment of the governor-to-carburetor control rod to insure wide open throttle at full load demand of governor, as follows. With engine stopped, advance engine speed control hand lever to create tension on the governor spring. Adjust length of governor-to-carburetor control rod so that the rod slides freely into the throttle lever, when the throttle is wide open. Lengthen governor-to-carburetor control rod by one turn in its clevis to place spring load on throttle lever, insert cotter pin and tighten lock nut on clevis. Return the speed control hand lever to a position slightly advanced from low idle position. In this condition, check the governor-to-carburetor control rod for any tendency toward binding. It may be necessary to loosen the clevis lock nut and reposition the clevis slightly to insure both ends being in the same plane to eliminate binding (after which the lock nut is retightened). Refer to the division on governor for coverage of governor adjustments.

Assemble the choke control wire and tube, being sure full movement of choke valve is assured with the full movement of choke control knob.



INSPECTION AND REPAIR

Before disassembly of the carburetor, clean the outside surfaces of dirt accumulations so that the solvent used to clean the dismantled parts will not become contaminated.

In order that individual parts may be given a thorough inspection, cleaning is important. The use of a good carburetor cleaning solvent is necessary to dissolve gum and varnish-like coatings commonly found in carburetors. The slow buildup of these coatings in jets and calibrated openings of the carburetor restricts the normal flow of fuel, and must be completely dissolved and removed to restore the original fuel flow characteristics. Where a good commercial carburetor cleaner is not available, equal parts of alcohol and benzol may be used.

After the dismantled parts have remained in the solvent long enough to dissolve the coatings, remove and rinse in petroleum base cleaning solution. Dry all parts with compressed air, blowing through all jets and channels in both directions to assure that they are clear and clean.

CAUTION: Do not use drills or wires to clean calibrated openings; any slight enlargement of these jet openings will affect the operation. Use only gum solvent and compressed air for cleaning.

Throttle Body and Fuel Bowl

The castings should be inspected for damage or broken flanges. Check mating surfaces for warpage. Where such warpage does not exceed 0.010 inch, the surface involved may be lapped on a flat surface using "00" sandpaper. Clean thoroughly after the sanding operation.

Normal clearance between the choke shaft and bowl casting bore is 0.002 to 0.005 inch. Where use of a new shaft will still result in a shaft clearance of 0.007 inch or more, the bowl casting should be replaced. Excessive wear at this point makes it impossible to seal out dirt at the seals.

The normal clearance between the throttle shaft and throttle body bore is .001 to .002 inch. Where the use of a new throttle shaft will not hold the clearance below 0.005 inch, the throttle body assembly should be replaced. Excessive wear of this throttle shaft bore will result in dirt and air leakage past seals and poor alignment of the throttle plate, affecting engine idling and governor action.

Throttle Plate

The throttle plate should be inspected for burrs or damaged edges which would prevent good contact with the throttle body bore when fully closed. Never use a buffing wheel or wire brush to clean this plate, its sharp edges must not be deformed.

When installing the throttle plate, insert it into the shaft from the top of the throttle body with the short end of the plate down (measured from the holes). Insert screws from the top, but do not tighten until the throttle plate is centered in the body bore.

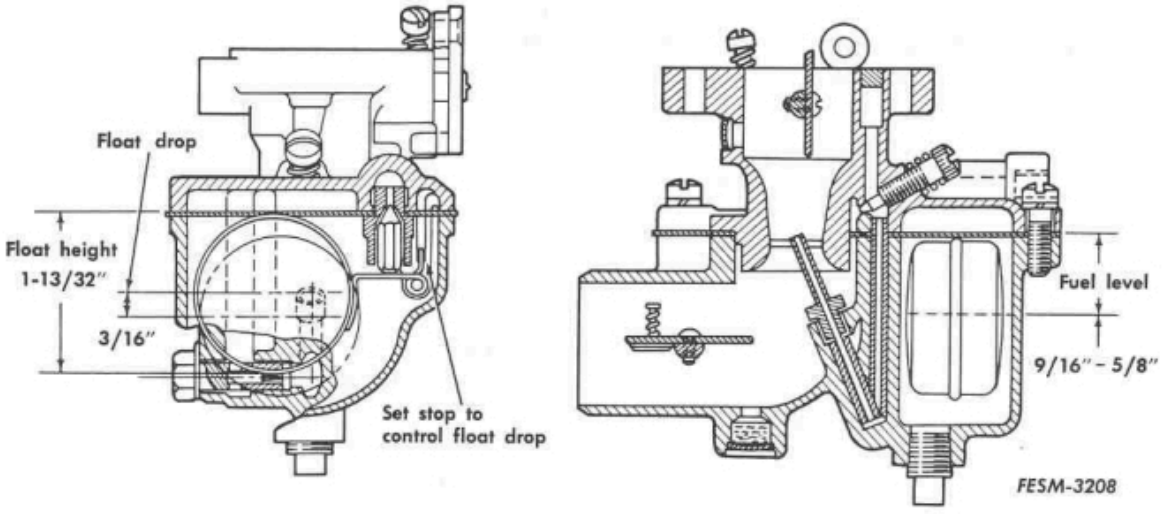
Unscrew the throttle stop screw until the plate is allowed to close fully. Holding the shaft lightly in the closed position, tap lightly on the face of the throttle plate with a brass rod to jar it into a centered position. The screws may then be tightened. The throttle plate must fit the bore closely with a minimum of light showing around its edges. The throttle shaft must be perfectly free to turn without binding at any point.

Clinch over the exposed end of the throttle plate screws to lock them in place. This can be done by using special plier FES 36-4. This must be done with care to prevent distortion of throttle shaft or plate.

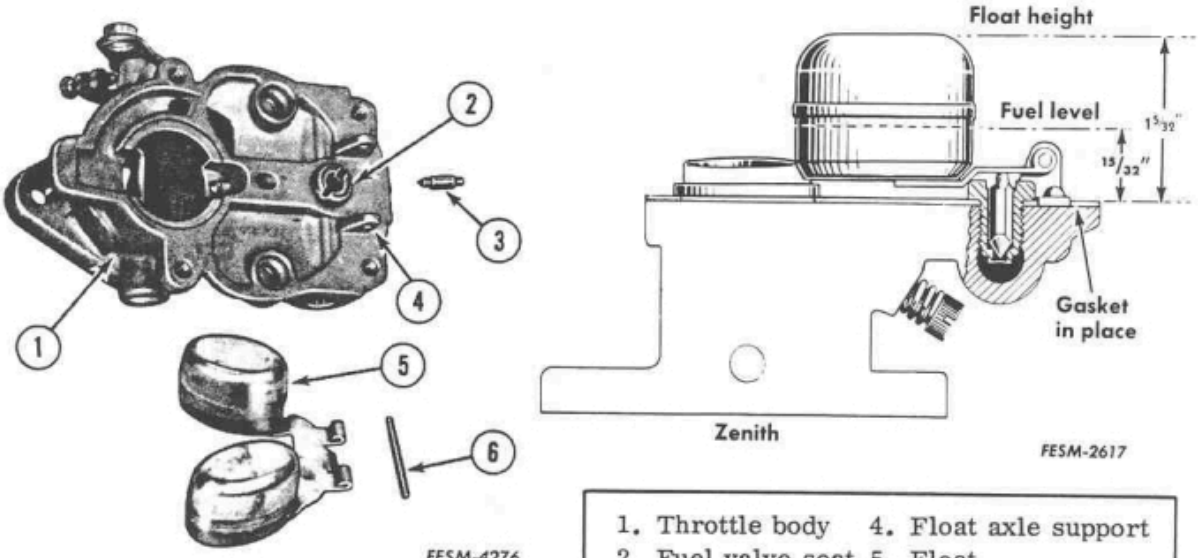
Float Assembly

Replace the float assembly if float is loaded with fuel or if the float lever axle bearing is worn excessively. Inspect top side of the float lever for wear where it contacts the fuel needle valve.

The float axle should be replaced if any wear can be detected on its bearing surfaces.



IH CARBURETOR

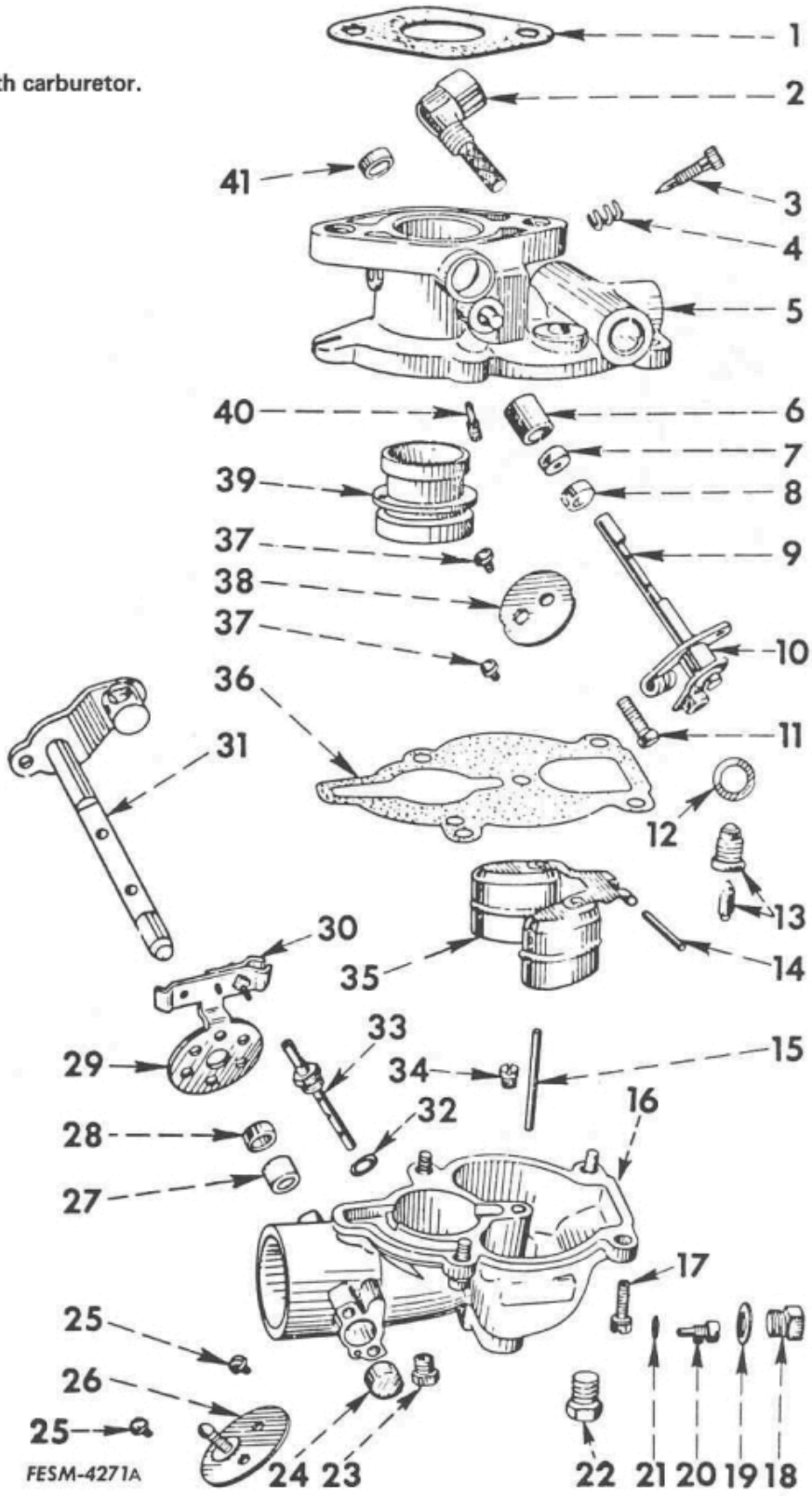


1. Throttle body	4. Float axle support
2. Fuel valve seat	5. Float
3. Fuel valve	6. Float axle

ZENITH CARBURETOR

Exploded View – Zenith carburetor.

1. Gasket
2. Elbow and strainer
3. Idle adjusting needle
4. Spring
5. Throttle body
6. Throttle shaft bushing (if used)
7. Throttle shaft seal
8. Seal retainer
9. Lever and shaft
10. Taper pin
11. Throttle stop screw
12. Fuel valve washer
13. Fuel valve and seat
14. Float axle
15. Idle filler tube
16. Fuel bowl
17. Screw
18. Lower plug
19. Fibre washer
20. Main jet
21. Washer
22. Drain plug
23. Drip plug filter
24. Plug
25. Screw
26. Choke plate
27. Washer
28. Packing retainer
29. Choke valve bracket
30. Bracket clamp
31. Lever and shaft
32. Fibre washer
33. Main discharge jet
34. Well vent jet
35. Float assembly
36. Gasket
37. Screws
38. Throttle valve plate
39. Venturi
40. Idling jet
41. Plug



Diagnosing Engine Troubles

Servicemen should not be too quick in condemning carburetor operation. Poor fuel economy, loss of power, poor recovery from overload, or poor acceleration are not necessarily results of inadequate carburetion. Fuel system conditions that can affect fuel economy, while important, are relatively few in number. Make sure that none of the following conditions exist; but don't limit your investigation to the fuel system.

Fuel system conditions affecting fuel economy:

1. Float valve leakage or high fuel level.

2. Damaged or enlarged jet openings.

3. Unbalanced conditions due to bowl gasket failure or dirt-plugged air bleeds or vents.

4. Poor setting of idle adjustment to match fuel or to meet a continuing load condition.

5. Failure to return choke valve to full open position.

6. Plugged air intake and/or air cleaner.

Fuel system conditions affecting power loss:

1. Low fuel float level.

2. Obstructed fuel passages, jets or screens from dirt or fuel gum.

3. Obstructed air bleeds in carburetor.

4. Lean setting of idle adjustment.

5. Air leakage between carburetor and manifold or between manifold and intake valve ports, or cracked intake manifold.

NOTE: Conditions where engine would draw in unfiltered air will also result in rapid and excessive engine wear from dust and abrasives.

6. Carbon or coke in intake manifold, at hot spot or heated jacket, restricting the amount of air-fuel mixture available to the engine.

7. Excessive clearance between throttle shaft and throttle body.

8. Poor governor action due to wear, misalignment or binding of moving parts.

9. Plugged air intake and/or air cleaner.

Governor

PRINCIPLES OF OPERATION

The engine governor is of the fly-ball, variable-speed type. It is designed to maintain a selected engine speed within reasonably constant limits under varying load conditions, by proportioning the fuel to the load.

For its action, the governor depends upon centrifugal force developed by weights rotating about a shaft. A variable governor spring is used to counteract the centrifugal force or outward movement of the weights. This movement of the governor weights, through suitable linkage, controls the carburetor throttle opening.

When the operator starts the engine and sets the engine speed control lever for a desired speed, the governor weights move outward with the increasing speed until the centrifugal force on the weights counterbalances the tension of the governor spring. When this condition is reached, the carburetor throttle has also been moved to a position where the air-fuel mixture admitted is sufficient to maintain this desired speed.

The operator controls engine speed by use of the engine speed control lever, increasing or decreasing the governor spring tension -- not by direct connection with the carburetor throttle valve.

Increasing the governor spring tension moves the governor weights inward which, in turn, moves the throttle further open, thereby increasing the engine speed until the increased centrifugal force of the governor weights counterbalances the greater spring tension.

Decreasing the governor spring tension allows the centrifugal force to move the weights outward, closing the throttle and thereby decreasing the engine speed until the decreasing centrifugal force and the reduced spring tension again balance each other.

When a change in load occurs, there is a momentary change in engine speed. This causes the governor weights to move inward or outward, thereby opening or closing the throttle sufficiently to maintain a reasonably constant engine speed up to the full load capacity of the engine. The speed variation between fast idle and rated load speed will normally be about 10 percent in these tractor governors.

Adjustment is provided in the linkage between the governor and the carburetor to synchronize the position of the throttle with a position of the governor weights. This adjustment is most important, since it insures the full power response of a wide open throttle when the governor weights are collapsed by the reduction in speed due to application of a full load to the engine.

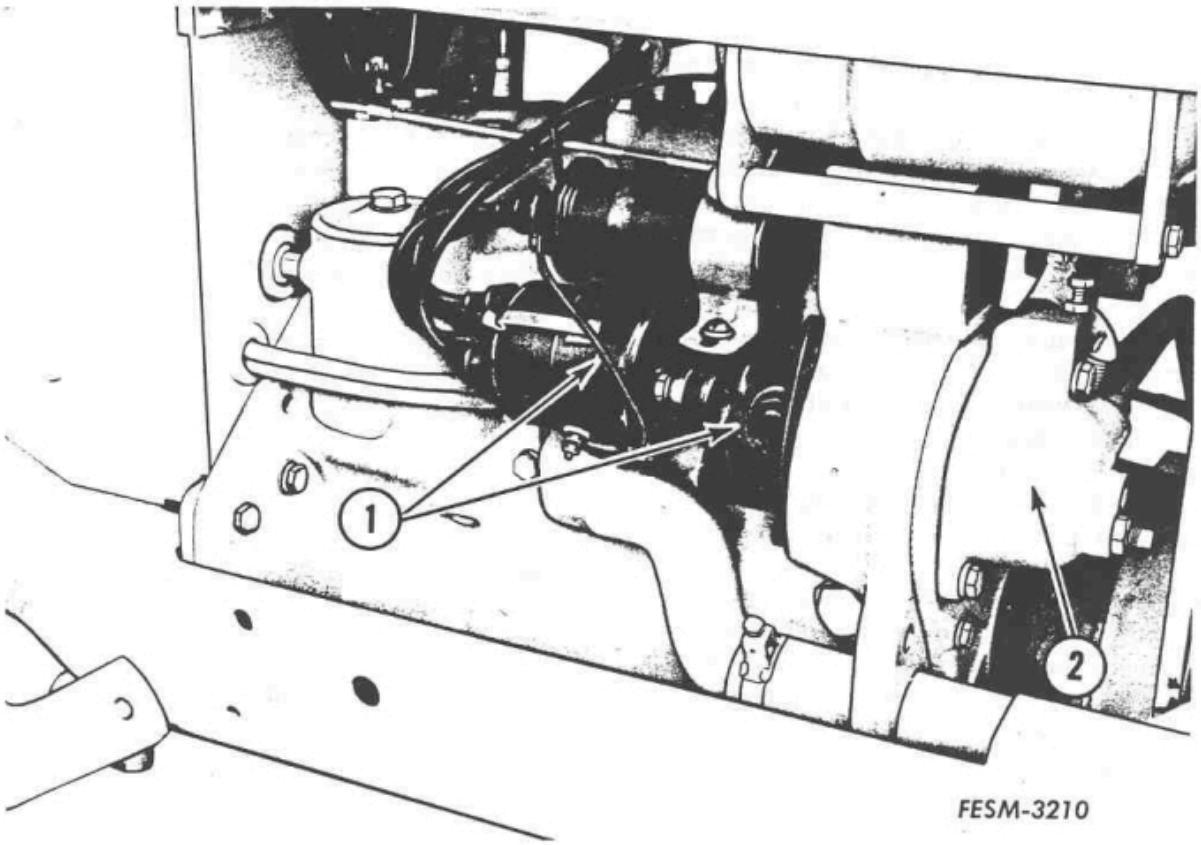
In review: With an engine supporting its load and maintaining a desired governed speed, three factors have reached an almost perfect balance. These are the forces of (1) governor spring tension (2) centrifugal force on governor weights, counteracting the effects of (3) load on the engine speed. Slight changes in load (within engine capacity) will cause slight changes in engine speed, upsetting the balance of forces and thereby opening or closing the carburetor throttle until the forces are again brought into balance.

To insure smooth, surgeless, and prompt response of the governor, all of its moving parts and linkage must move freely to follow slight changes in engine load-speed. Should binding occur at any point, a greater change in speed will take place before sufficient centrifugal force or spring tension is built up to overcome the friction and move the throttle valve. Friction increases and binding often occurs because of wear and misalignment of the carburetor throttle shaft. Sludge deposits in the governor housings can cause sluggish or rough action of governor parts and linkage. Wear of governor weights, pins, sleeve, rockshafts, or rockshaft lever also result in surging and erratic governor action.

REMOVAL, INSPECTION AND REPAIR

The governor drive gear also serves as the ignition unit drive. The governor drive gears are marked for proper mesh with mating gears at top dead center of number one cylinder compression stroke. Some reassembly time may be saved if the engine is turned to this position before removal of the governor assembly.

Before removing any of the governor assemblies for inspection or repair, clean the surrounding area and the various connecting points to prevent entry of dirt into those parts which remain with the engine.



FESM-3210

1. Ignition unit
2. Governor assembly

After disassembly of the governor, start the cleaning of parts with a clean container of clean solvent. Wash ball bearings first. Do not spin bearings while washing. Turn them slowly back and forth while dipping the bearing up and down in the solvent to dislodge dirt. Blow out with compressed air, holding the parts to prevent the air blast from spinning them, to avoid possible scratching of balls and grooves. Flush again in clean solvent and blow-dry a second time. Examine under good light to determine if further cleaning is necessary. Add a few drops of oil to the balls and grooves, then, and only then, spin by hand to test for roughness and wear.

Wash and clean the remainder of the rotating parts in solvent, examining the weights, carrier and weight pins for damage or wear. Clearance between new weights and new pins for each governor is .001 to .004 inch. Clearances found to exceed those specified by 0.003 inch or more would be considered excessive and parts should be renewed.

Wash and clean the housing and remaining parts and examine each for damage or excessive wear. No attempt should be made to salvage old gaskets or seals. They should be carefully removed from the assembly and replaced with new to insure an oil tight, dust proof operation.

Where sludge accumulations are found in the governor housing, corrosion of bearing surfaces may have occurred. These rough bearing surfaces and their increased frictional drag are responsible for poor governor action. Excessive bearing clearance also results from sludge corrosion.

The decision on what new parts should be used to rebuild the governor assembly will be based upon the wear found and the condition of the following groups of parts:

1. Weights, pins, and weight carrier: Clearance in excess of 0.003 inch over that specified between pins and weights or carrier.

2. Governor shaft bearings and thrust bearing: Rough, pitted bearing surfaces of either plain or ball type bearings.

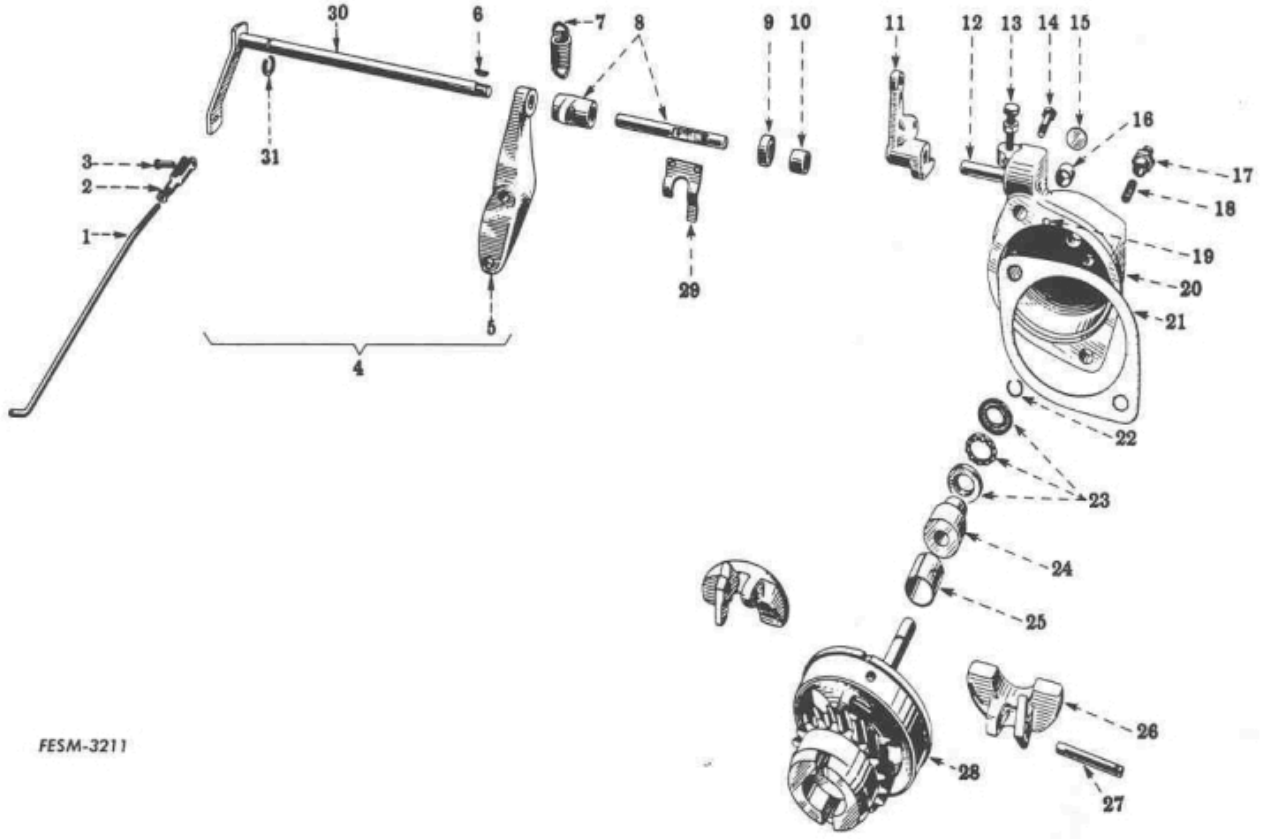
3. Rockshaft, rockshaft fork, bearings and levers: Worn or damaged rockshaft, rockshaft fork or spring levers. Rough, pitted bearings and bearing surfaces.

Where all three conditions are found, the use of new complete governor assembly should be considered, since the few parts which can be salvaged may not cover the labor cost of overhaul.

Where conditions 1 and 2 are involved, the rotating assembly, including new bearings, weights and pins, should be used.

Where only the governor weight and pin clearance is found questionable, only these individual parts need be replaced. In all cases new gaskets and new seals must be used to prevent entry of dirt and loss of oil.

Examine hook ends of governor springs and mating holes in spring levers for wear. Replace these parts where appreciable wear is found.

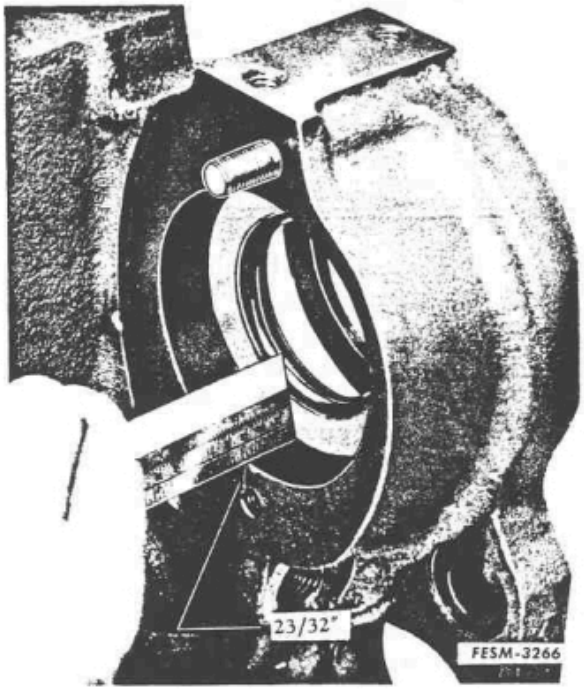


1. Governor connecting rod
2. Adjusting rod end clevis
3. Rod end pin
4. Rockshaft and bracket extension assembly
5. Rockshaft extension bracket
6. Woodruff key
7. Governor spring
8. Governor and spring rockshaft assembly
9. Rockshaft oil seal
10. Rockshaft bearing
11. Spring throttle lever
12. Throttle lever shaft
13. Speed change lever stop
14. Screw
15. Expansion plug
16. Governor shaft bushing
17. Bumper spring body
18. Bumper spring
19. Governor base dowel pin
20. Governor housing assembly
21. Governor housing gasket
22. Governor sleeve stop ring
23. Governor thrust ball bearing
24. Governor thrust bearing
25. Governor base bushing
26. Governor weight
27. Governor weight pin
28. Governor with carrier and pin shaft
29. Governor tension fork
30. Rockshaft extension assembly
31. Rockshaft extension stop ring

Care must be taken in the reassembly of the governor rockshaft, rockshaft fork, bearings and seal to insure uniformly smooth movement of the rockshaft from one extreme of movement to the other. Lubricate the rockshaft oil seal thoroughly upon installation. Some slight friction resulting from drag of the oil seal on the shaft is unavoidable, but friction from any other source must be held to a minimum.

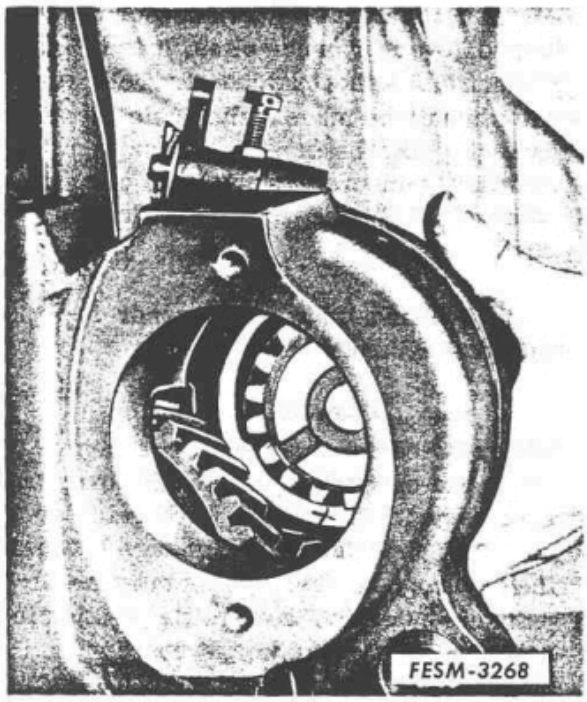
Any rough, jerking movement of the rockshaft must also be eliminated to prevent surging and erratic governor action.

Governor shaft end clearance is adjusted by placing 0.020 inch thickness of feeler gauge stock between drive gear and governor base when pressing the gear on the assembly. After gear is pressed in place, the end clearance should be within the range of 0.020 to 0.025 inch.



INSTALLATION AND ADJUSTMENT

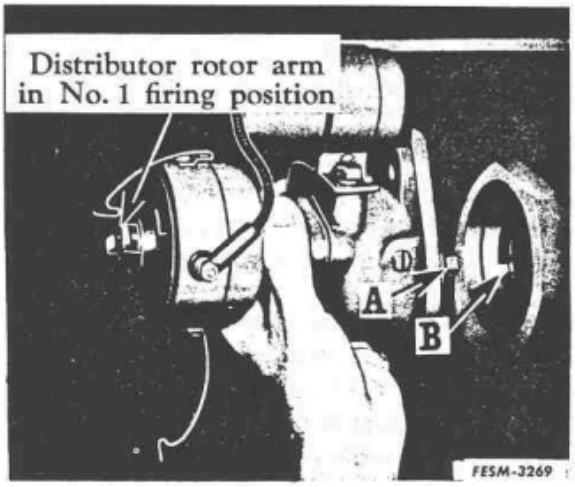
Install the governor - ignition drive oil seal with seal lip facing forward; the seal must be square in the crankcase bore and positioned 23/32 inch in from the ignition mounting flange face. The seal mating surface on the outside diameter of the gear hub must be smooth and free of cuts or scratches to prevent rapid wear or damage to seal lip. Any sharp edges on gear hub slots should be removed to prevent damage to seal during installation of governor assembly.



Install the governor assembly and ignition unit using new mounting gaskets, insure proper ignition timing as follows:

1. With the engine positioned at top dead center of number one cylinder firing stroke, locate the single punch mark between teeth of idler timing gear. Use chalk to mark top surface of two teeth on each side of punch mark.

2. Chalk the rear end of the punch marked tooth on the governor drive gear.



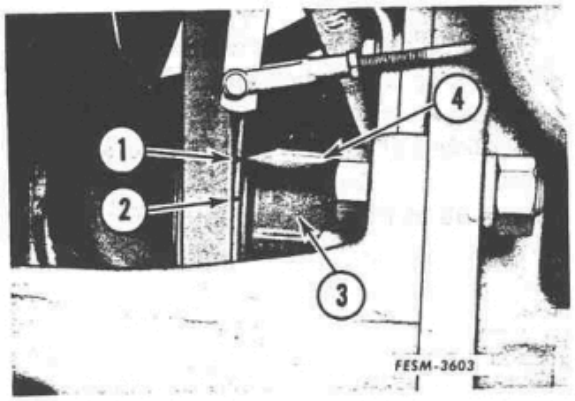
3. Install the governor assembly, meshing the marked gear teeth.

4. Position the ignition unit distributor rotor arm and (A) drive shaft lugs for firing number one cylinder. Install ignition unit on engine, meshing (A) lugs and (B) drive slots.

NOTE: Remove spark plug cables 2, 3 and 4 and ground them to prevent any chance of accidentally starting the engine.

5. Remove the number one spark plug cable from the number one spark plug and position the end of the cable so a spark discharge to "ground" will be audible while hand cranking the engine.

6. Advance or retard ignition distributor until spark occurs as the mark (1) on the fan drive pulley (3) aligns with pointer (4) while <u>hand</u> cranking the engine.



1. Mark
2. 16° mark
3. Fan drive pulley
4. Timing pointer

After installation of either new or overhauled governor assemblies, it is important that a thorough check of all four adjustments be made. The basic governor assembly may be in perfect condition, but in order to insure its full range of control it must be adjusted to its individual engine.

1. Synchronizing the governor-to-carburetor throttle movement.

Because of possible change in center-to-center distance between governor and carburetor, due to removal and replacement of manifold, carburetor or governor assemblies, the linkage between the governor and carburetor must be adjusted to establish the throttle position in relation to governor weight position. This adjustment insures the full power response of a <u>wide open throttle</u> when the governor <u>weights are collapsed</u> by reduction in rpm by application of heavy load. This governor-to-carburetor linkage must be free from binding throughout its range of movement. Adjustment procedure for all engines follows:

(a) With engine stopped, advance the operator's engine speed control lever to about half speed position; sufficient to create tension on the governor spring.

(b) Disconnect governor-to-carburetor control rod (either end). Hold carburetor throttle against its stop in wide-open position and adjust length of governor-to-carburetor control rod so that it may be reconnected freely without moving throttle lever or governor lever.

(c) <u>Lengthen</u> control rod one turn from the above condition, to compensate for wear, and reconnect.

d. After tightening the control rod clevis lock nut, check to be sure that both ends of the control rod are in the same plane, to eliminate possibility of binding on levers.

e. Move operator's engine speed control lever a few times between half speed and low speed position, checking the governor-to-carburetor control rod in all positions for interference or binding.

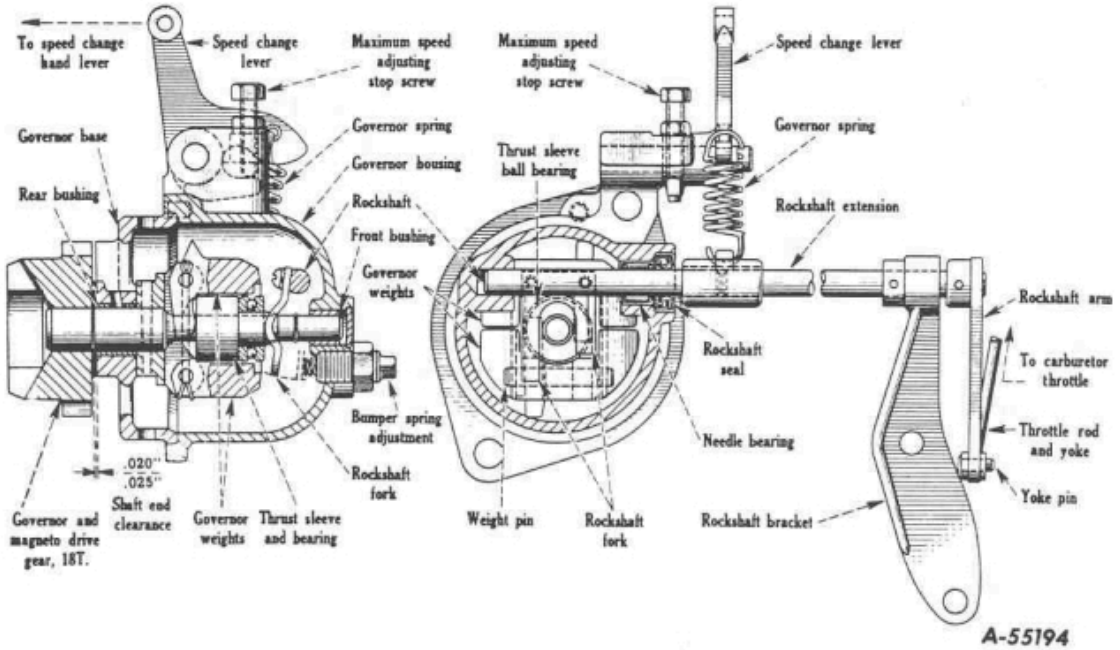
2. Adjusting governed fast idle speed.

To protect the engine from excessive speed, and also to provide sufficient speed to maintain the engine's rated load, the governed fast idle speed adjustment must be properly made. Be sure the service tachometer used is accurate. Do not expect the tractor tachometer to be sufficiently accurate for this operation. Adjustment procedure for all engines follows:

a. Before adjustment is attempted, the engine must be brought up to operating temperature. Engine lubricant viscosity should be correct for the season of use and should be near operating temperature.

b. With engine running and accurate service tachometer in use, advance operator's engine speed control lever to maximum speed position. Be sure also that operator's speed change linkage is being held firmly against the governor maximum speed stop adjustment; reset linkage if necessary.

c. Adjust the governor maximum speed stop screw or adjustment to secure specified fast idle speed. Be sure that governor speed change linkage is being held against the stop screw in its new position when the tachometer reading is taken.



NOTE: Adjustment of the maximum speed stop, to allow increased tension to be placed on the governor spring by the operator's engine speed control lever, will result in increased engine speed. Adjustment to reduce tension which can be placed on the governor spring, will result in reduced engine speed.

3. Low idle speed adjustment.

Smooth low speed engine operation depends upon careful adjustment of carburetor idle air-fuel mixture at the specified engine low idle speed. Good governor performance also is dependent on this smooth engine operation and free throttle shaft movement near closed throttle positions. Any tendency of the carburetor throttle to stick or bind in its low idle (closed) position will cause the governor to surge excessively. The governor is equipped with an adjustable bumper spring to counteract the effect of manifold vacuum on the closed position of the throttle.

Causes for binding or sticking of the throttle shaft are misalignment due to wear or interference due to improper assembly. Excessive tension adjustment of bumper spring, in an attempt to overcome these ills, will prevent the throttle from closing against its stop, resulting in greater than specified low idle speed. See carburetor "Inspection and Repair" portion of this manual section.

Low idle speed adjustment:

a. Start engine and allow it to reach operating temperature.

b. Place operator's speed change lever in the extreme low speed position. See that operator's speed change lever linkage will allow the throttle to close against its stop screw. Adjust speed change linkage if necessary. See also that governor bumper spring adjustment is not interfering with closing of throttle.

c. Adjust carburetor throttle stop screw to secure the specified low idle speed and set idle fuel mixture screw for smoothest engine operation.

d. Advance operators speed change lever for a few seconds and again idle the engine, rechecking adjustments for specified low idle speed and smoothest operation.

e. Place operators speed change lever in maximum speed position. Notice the fast idle speed on service tachometer. With thumb and finger pull the carburetor throttle lever toward open position sufficient to gain 50 rpm fast idle speed. Release throttle lever instantly; the governer will react by closing the throttle and opening again seeking its balance. If the governor surges move more than twice, bumper spring adjustment is necessary. Excessive surging would indicate binding in the carburetor throttle assembly or the governor rockshaft and linkage assembly as outlined previously under carburetor and governor headings.

f. Bumper Spring Adjustment: Screw in the bumper spring just enough to stop excessive surging. Test as in operation (e) above after each slight adjustment. If screwed in too far, the bumper spring will prevent the throttle from closing to low idle stop. After the bumper spring has been adjusted properly, lock in place with a jam nut. Where such extreme setting of the bumper spring is found necessary, it would indicate excessive friction or sticking is occurring in the throttle assembly or the governor rockshaft assembly. This should be corrected and the bumper spring readjusted. Where the use of the bumper spring is not required to control surging, it should be screwed in until it just touches at low idle speed, and then backed out 1/4 turn and locked.

4. Operator's engine speed control lever linkage.

In the preceding adjustments covering fast idle and low idle speeds, it was noted that some readjustment of the operator's speed control lever linkage may be required in each case. This may have been found necessary in order to contact the maximum speed stop at one extreme, or to contact the throttle lever stop screw at the other extreme.

After both fast idle and low idle speed adjustments have been completed, it is suggested that both extremes of speed be rechecked with the service tachometer, to be sure that the operators control is capable of moving the system into contact with both stop adjustments. Failure to attain either stop (with engine running) would require readjustment of linkage. Where considerable lost motion in the linkage has occurred because of wear, the worn parts must be replaced to restore a full range of movement to governor speed change lever. Loose brackets, which act as supports for linkage levers and bellcranks, will also result in lost motion and failure to secure full range of engine speeds.

Section 3

STEERING, FRONT WHEELS AND FRONT AXLE

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SPECIFICATIONS

Front Wheels

Bearings	Tapered roller
Toe-in-inch	1/4 ± 1/16
Turning radius	8-1/4 ft.

Front Axle

Construction	Welded steel tube
Pivot shaft diameter - inch	.874 to .875
Pivot shaft bushing ID (installed and reamed) - inch	.876 to .878
Spindle diameter	
Oil seal location - inches	1.749 to 1.752
Inner bearing location - inches	1.2493 to 1.2498
Outer bearing location - inch	.7493 to .7498
Steering knuckle vertical shaft diameter - inch	.9975 to .9985
Steering knuckle shaft bushings	Bronze
ID (installed and reamed) - inches	1.001 to 1.003
Thrust taken by	Machined upper surface of the knuckle and lower flange of vertical shaft tube

Steering Gear

Type	Worm and gear with center-point control
Steering worm shaft diameter at bearing location - inch	.873 to .874
Steering worm shaft diameter at pilot end-inch	.561 to .562
Steering worm shaft bearing ID - inch	.875 to .876
Steering worm to gear backlash - inch	.004 to .006
Steering worm shaft end clearance - inch	.001 to .011
Steering worm wheel number of teeth	24
Steering worm wheel shaft	
Diameter at upper bushing location - inches	1.1260 to 1.1265
Diameter at lower bushing location - inches	1.1260 to 1.1265
End clearance - inch	.001 to .011
Steering worm wheel shaft bushings	Bronze
ID after installing in upper housing - inches	1.1285 to 1.1305
ID after installing in housing base - inches	1.128 to 1.129
Thrust taken by	Lower bushing flange

Housing (upper)

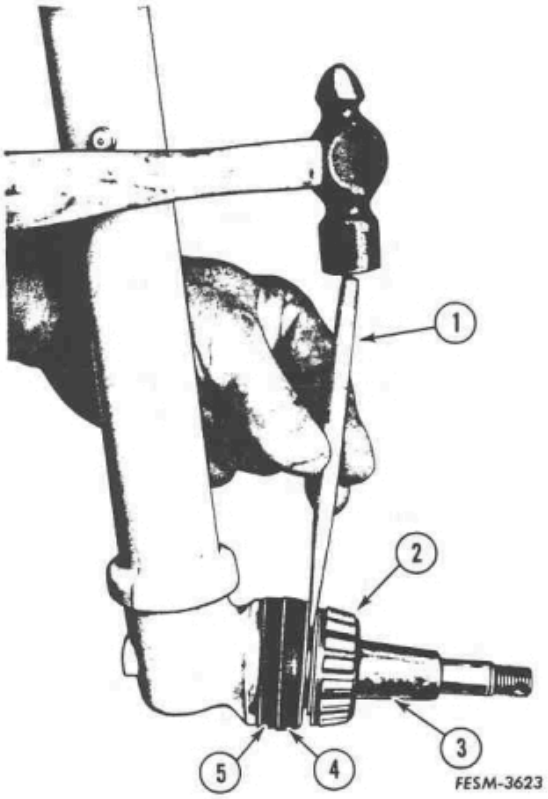
Bore for steering worm shaft pilot end - inch	.563 to .565
Bore for worm gear shaft upper bushing - inches	1.249 to 1.251
Bore for expansion plug - inches	2.250 to 2.256

Housing Base

Bore for worm gear shaft lower bushing - inches	1.3755 to 1.3765
Bore for worm gear shaft lower oil seal - inches	1.560 to 1.562
Worm gear shaft oil seal	Installed with lip toward lubricant

FRONT WHEELS AND BEARINGS

Removal



1. Chisel
2. Inner bearing
3. Spindle
4. Oil seal
5. Felt washer

1. Lock the tractor brakes, jack up the front end and support it on a suitable stand.

2. Remove the cap screws securing the front wheel and set the wheel aside.

3. Clean the exterior of the wheel hub, and then remove the hub cap.

4. Remove the cotter pin and remove the bearing retainer nut.

5. Remove the hub and the outer bearing assembly.

6. The inner bearing cone may be snug on the spindle. To remove it, place a small chisel (1) between the bearing (2) and the oil seal (4) and tap lightly to start cone movement. Remove cone completely by pulling it off the spindle (3).

7. Remove the front wheel oil seal (4) and the felt washer (5).

8. If the bearings are to be replaced, remove the bearing cups from the wheel hub. When driving the cones out, be sure to use a soft brass drift to prevent damaging the wheel hub.

Inspection and Repair

1. Thoroughly clean the inner and outer bearings, including the bearing cups in the hub. Use solvent and compressed air.

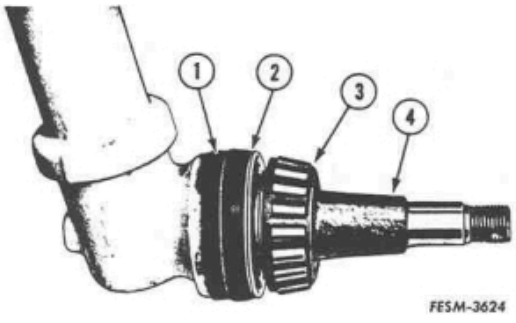
NOTE: Do not allow bearings to spin while drying with compressed air.

2. Inspect the bearings for roughness, pitting or other damage. Replace as necessary.

3. If the bearings are replaced, the oil seal and felt washer are also worn and must be replaced.

4. Pack the wheel bearings with grease before installation.

Installation



1. Felt washer
2. Oil seal
3. Inner bearing
4. Spindle

1. Lubricate the felt washer (1) and oil seal (2) before installing them on the spindle. The oil seal can be driven into place using a proper size sleeve. Be sure the oil seal lip points toward the felt washer.

2. Install the inner bearing (3) on the spindle (4). Do not apply pressure to the outer part of the bearing; apply only to the inner race.

3. Install new bearing cups in the wheel hub if they were removed.

4. Install the hub and the outer bearing on the spindle.

5. Install the bearing retaining nut.

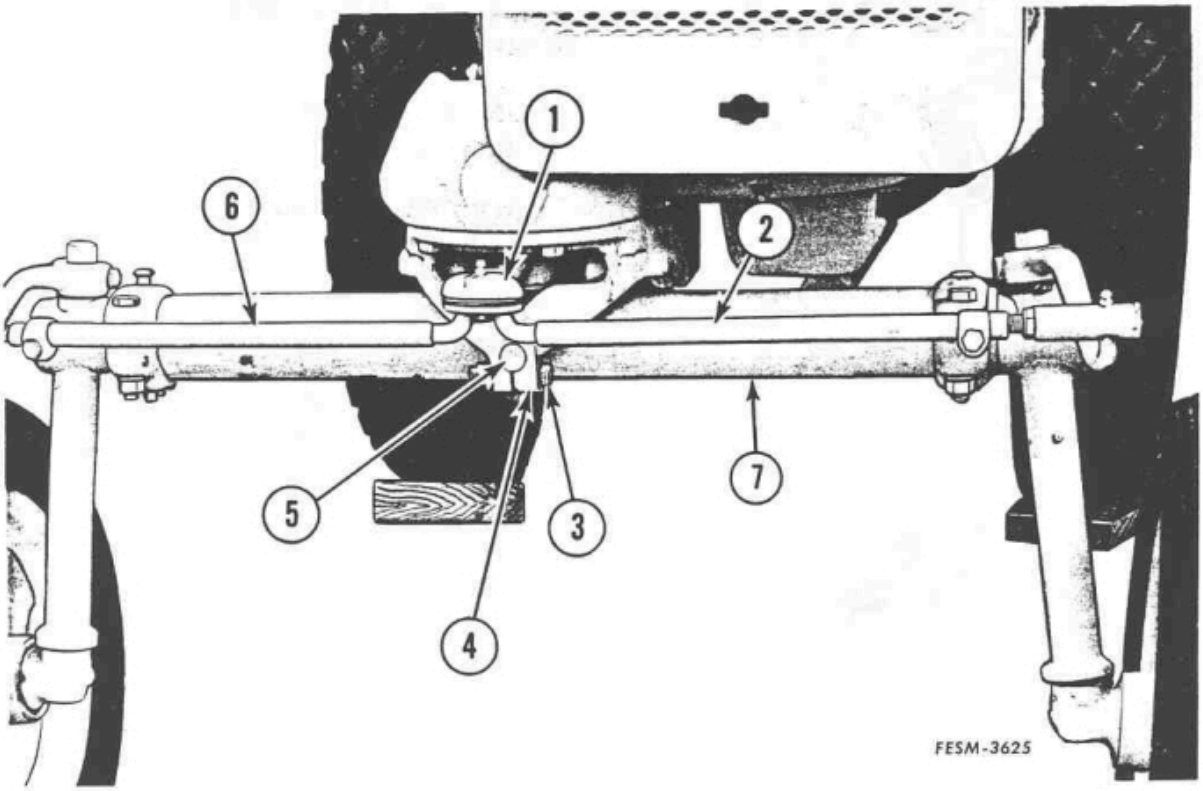
6. Install the wheel on the hub and rotate it while tightening the retaining nut until a slight drag is felt on the wheel.

7. Back the nut off to the nearest castellation and insert the cotter pin.

8. Install the hub cap.

9. Refer to Operator's Manual for lubrication.

REMOVAL AND DISASSEMBLY OF FRONT AXLE ASSEMBLY



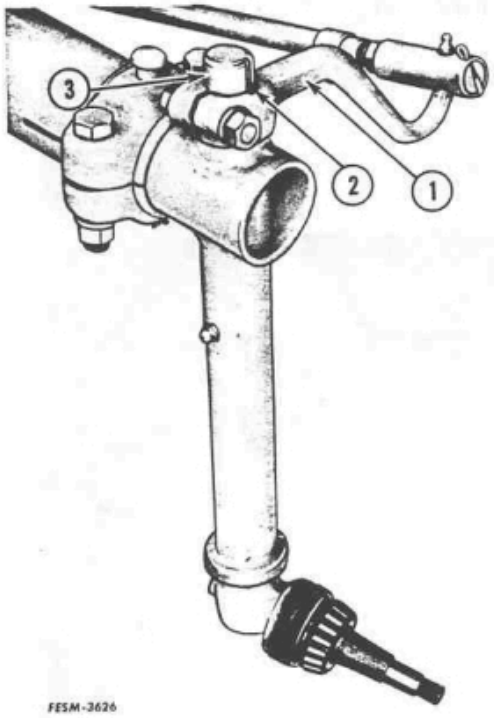
1. Steering gear arm
2. Tie rod
3. Bolt (2)
4. Steering gear housing base
5. Axle pivot shaft
6. Tie rod
7. Front axle

1. Disconnect the tie rods (2 and 6) from the steering gear arm (1).

2. Remove the nuts and bolts (3), one in front and one in back, securing the steering gear housing base (4) to the front axle pivot shaft (5).

3. Raise the front of the tractor and support it with the support stands, FES 142-1. Remove the axle pivot shaft from the axle.

4. Remove the front axle assembly from the tractor.



FESM-3626

5. Remove the steering knuckle arm (1) from the steering knuckle (3), and remove the key (2) from the steering knuckle.

6. Remove the steering knuckle (3) from the front axle.

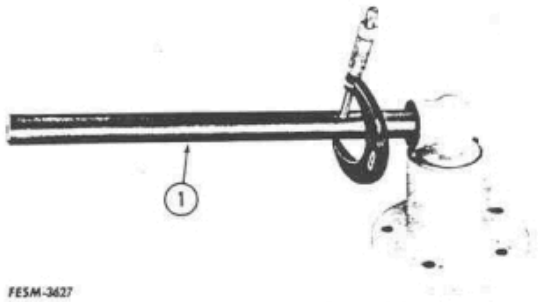
NOTE: When driving out the bushings, be sure to use a soft brass drift.

7. Remove the steering knuckle bushings from the axle if service is necessary.

8. Remove the axle pivot shaft bushings from the axle if they are to be replaced.

1. Steering knuckle arm
2. Key
3. Steering knuckle

INSPECTION AND REPAIR



FESM-3627

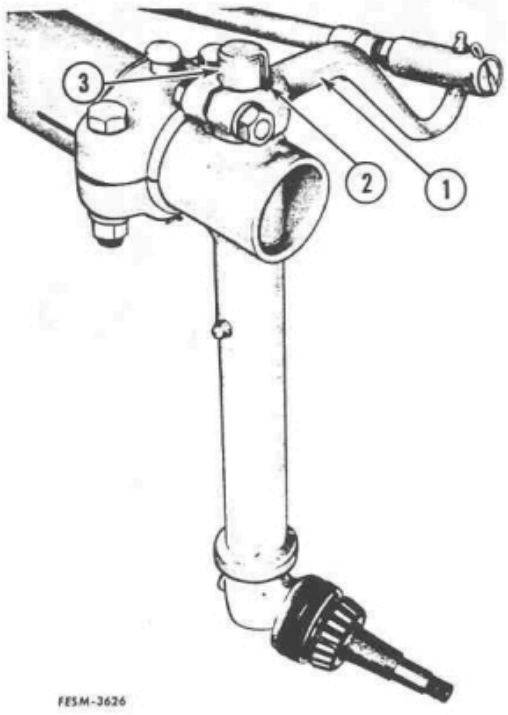
1. Steering knuckle assembly

1. Inspect the axle pivot shaft, thrust washers and bushings for wear or damage. Replace as necessary.

2. Inspect the steering knuckles (1) and bushings for wear or damage. (Refer to "Specifications.")

3. Inspect the steering knuckle arms, tie rods and axle for wear or damage. If any are bent out of alignment, straighten or replace as necessary.

REASSEMBLY AND INSTALLATION OF FRONT AXLE ASSEMBLY



FESM-3626

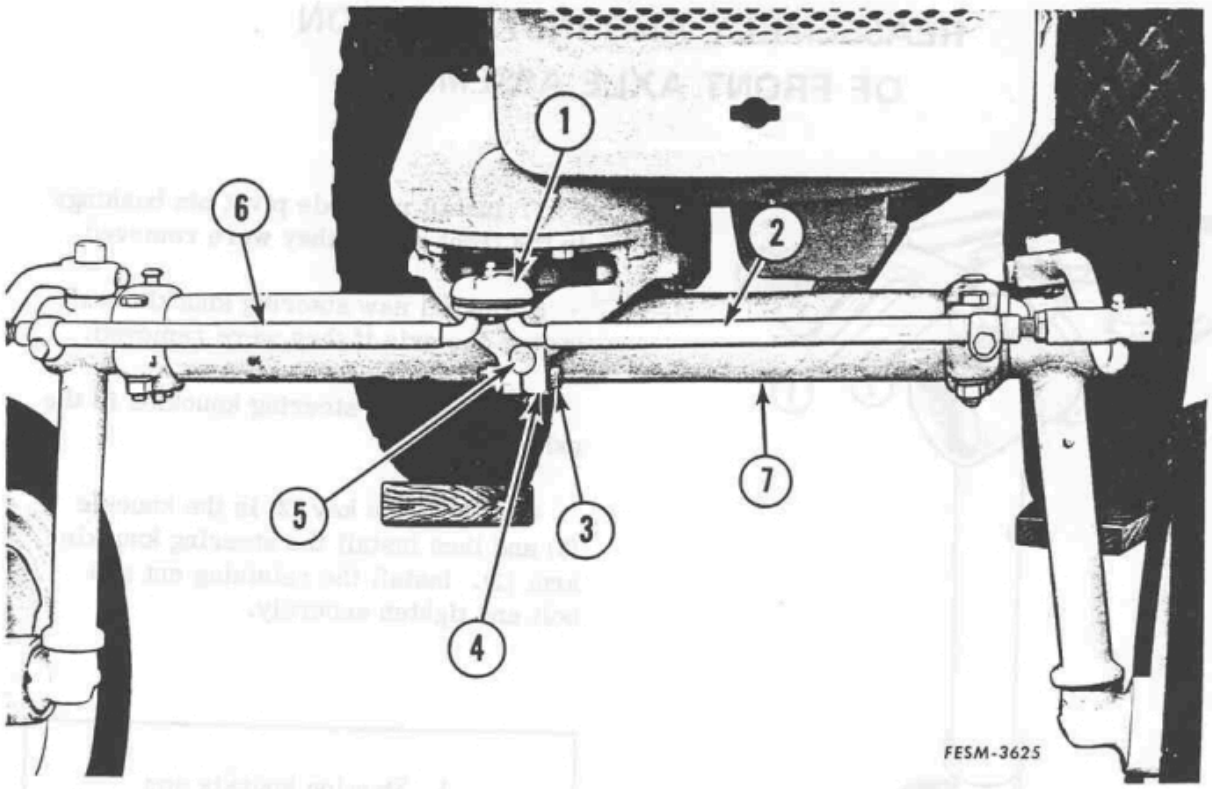
1. Install new axle pivot pin bushings in the front axle if they were removed.

2. Install new steering knuckle bushings in the axle if they were removed.

3. Install the steering knuckles in the axle.

4. Install the key (2) in the knuckle (3) and then install the steering knuckle arm (1). Install the retaining nut and bolt and tighten securely.

1. Steering knuckle arm
2. Key
3. Steering knuckle



1. Steering gear arm
2. Tie rod
3. Bolt (2)
4. Steering gear housing base
5. Axle pivot shaft
6. Tie rod
7. Front axle

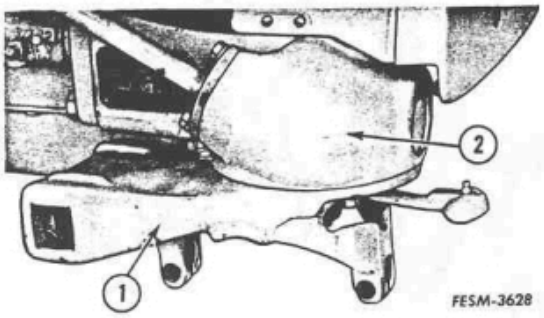
5. Position the front axle (7) under the tractor and install the axle pivot shaft (5) and thrust washers. Install the nuts and bolts (3) securing the steering gear housing base (4) to the pivot shaft (5).

6. Connect the tie rods (2 and 6) to the steering gear arm (1).

7. Check and adjust the toe-in. (Refer to page 3-16.)

STEERING ASSEMBLY

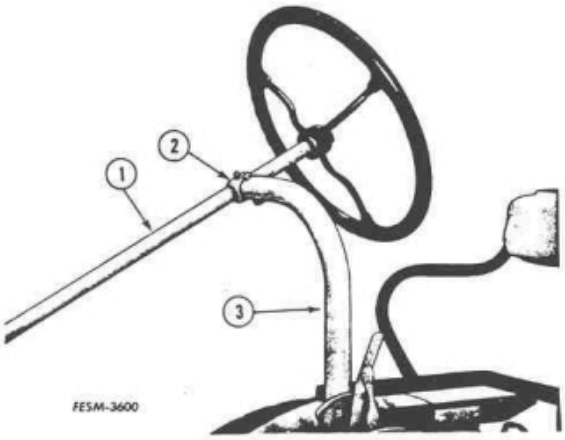
Removal



1. Housing base
2. Steering gear housing

1. Remove the front axle assembly. (Refer to page 3-5).

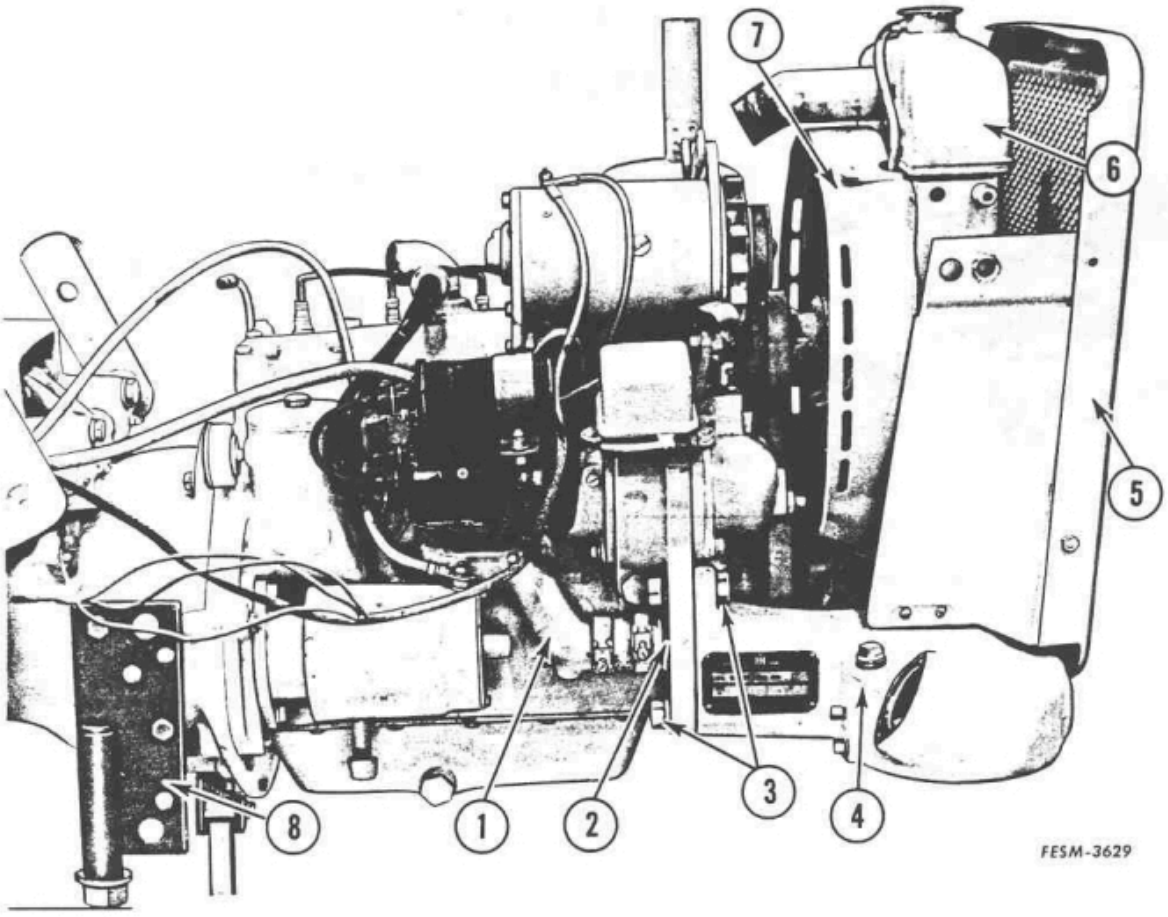
2. Drain the oil from the steering gear housing. Remove the cap screws securing the housing base (1) to the steering gear housing (2) and remove the base.



1. Steering shaft
2. Shaft support arm bracket
3. Shaft support arm

3. Disconnect the steering shaft bracket (2) from the steering support arm (3).

4. Remove the cap screws securing the steering shaft bearing and seal to the steering gear housing. Remove the steering shaft and worm from the steering gear housing.



1. Inlet elbow
2. Inlet nipple
3. Cap screw and bolt
4. Steering gear housing assembly
5. Radiator grille
6. Radiator assembly
7. Fan housing
8. Support stands FES 142-1

5. If the steering gear housing requires service, remove it as follows:

(a) Remove the headlights and the hood and fuel tank assembly.

(b) Drain the coolant and remove the radiator water inlet and outlet elbows and hoses.

(c) Remove the water inlet nipple (2) from the R.H. side of the steering gear housing.

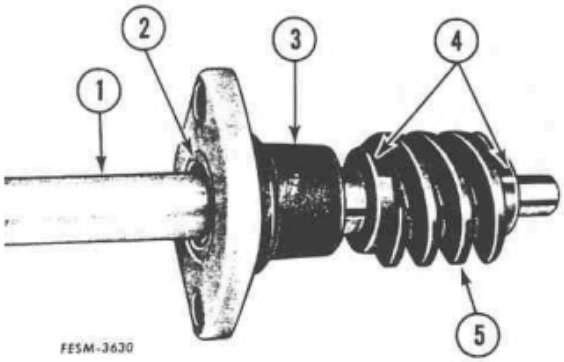
(d) Remove the screws securing the fan housing (7) to the radiator (6).

(e) Remove the cap screws and bolts (3) securing the housing (4) to the engine.

(f) Lower the steering gear housing so it clears the fan drive pulley, and remove the assembly from the tractor.

(g) Remove the radiator grille (5) and the radiator assembly (6) from the steering housing (4).

Disassembly

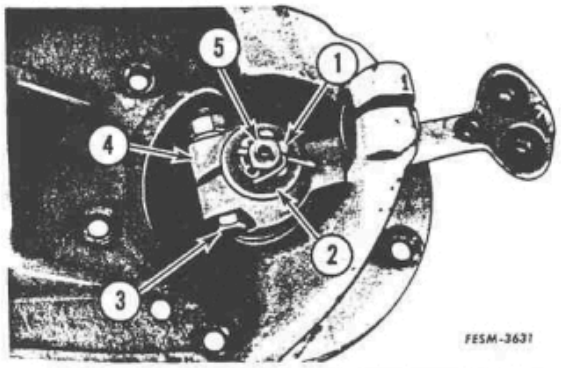


1. Steering shaft
2. Oil seal
3. Steering shaft bearing
4. Thrust washers
5. Worm gear

1. Remove the steering wheel from the steering shaft.

2. Remove the support bracket and the bearing and seal assembly (3) from the steering shaft (1). Drive the oil seal (2) out of the shaft bearing (3).

3. If the steering shaft thrust washers (4) are to be replaced, remove them from the steering shaft (1).



1. Nut
2. Washer
3. Bolt
4. Steering gear arm
5. Worm wheel shaft

4. Remove the cotter pin, nut (1) and washer (2) from the steering worm wheel shaft (5).

5. Remove the bolt (3) in the steering gear arm (4) and remove the arm (4) from the worm wheel shaft (5).

6. Remove the Woodruff key from the worm wheel shaft and remove the shaft thrust washer.

1. Worm wheel shaft
2. Steering worm wheel

7. Remove the shaft (1) and the steering worm wheel (2) from the housing base.

8. Drive the oil seal out of the base using a brass drift.

9. Remove the shaft lower bushing from the base using a soft brass drift if service is necessary.

10. Remove the upper shaft bushing from the steering gear housing if replacement is necessary.

Inspection and Repair

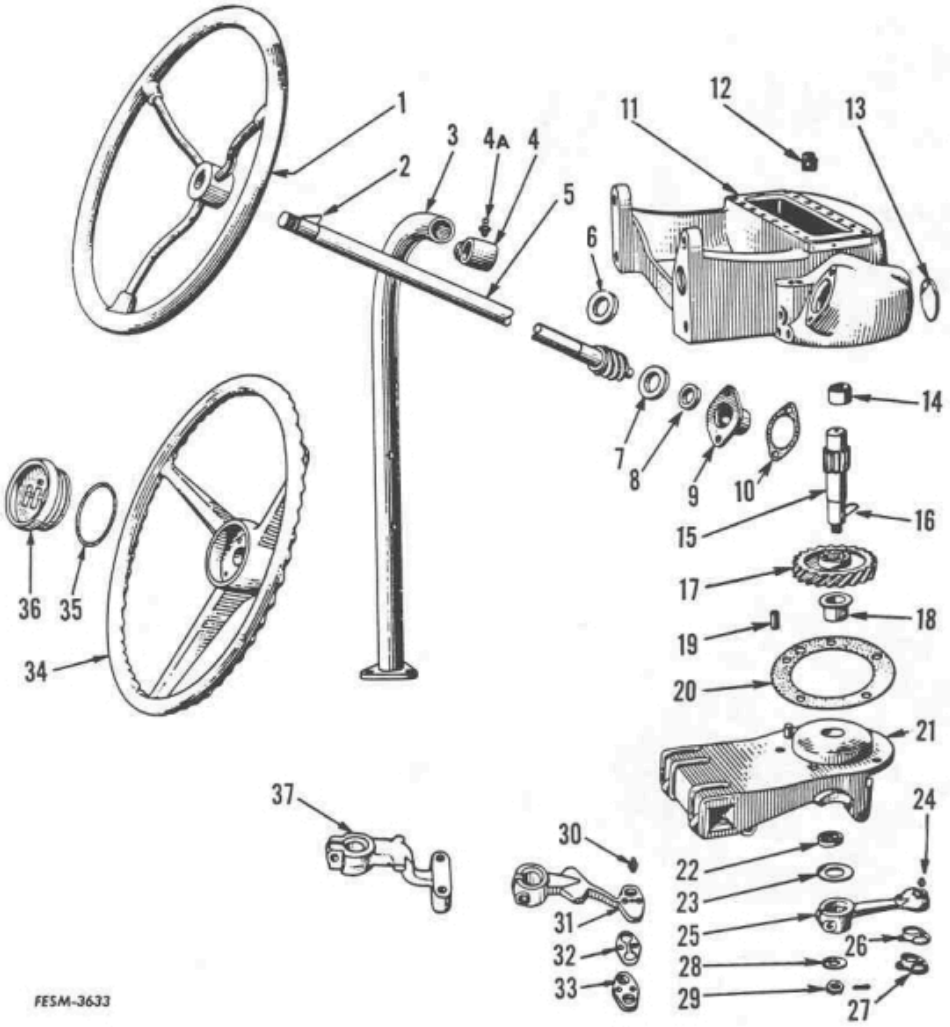
1. Inspect all bushings and bearings for pitting, wear and roughness of operation. Replace as necessary.

2. Inspect the steering shaft and worm for wear or damage. Check the steering shaft thrust washers for wear.

3. Check the steering worm wheel shaft, gear, bushings and thrust washer for wear or damage. If there is any doubt of serviceability, replace the parts.

4. Be sure to use new gaskets and oil seals in reassembly.

Reassembly



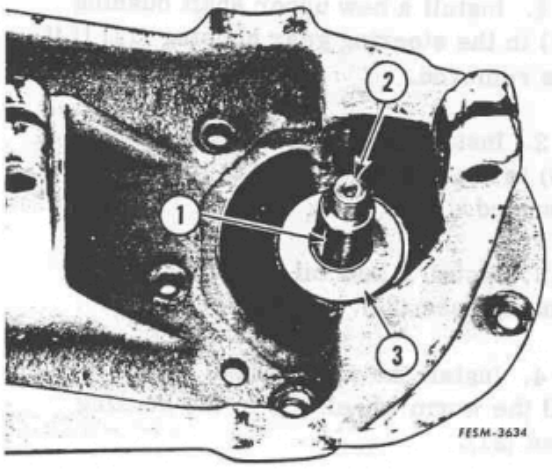
1. Steering wheel
2. Woodruff key
3. Steering shaft support arm
4. Steering shaft support arm bracket
4A. Lubrication fitting
5. Steering shaft and worm
6. Steering shaft upper thrust washer
7. Steering shaft lower thrust washer
8. Steering shaft oil seal
9. Steering shaft bearing
10. Steering shaft bearing gasket
11. Steering gear housing assembly
12. Oil filler plug
13. Expansion plug
14. Steering worm wheel shaft upper bushing
15. Steering worm wheel shaft
16. Woodruff key
17. Steering worm wheel
18. Steering worm wheel shaft lower bushing
19. Steering gear base dowel
20. Steering gear base gasket
21. Steering gear housing base
22. Steering worm wheel shaft oil seal
23. Steering worm wheel shaft thrust washer
24. Lubrication fitting
25. Steering gear arm
26. Steering gear arm plate shim
27. Steering gear arm plate
28. Steering gear arm retainer washer
29. Steering worm wheel shaft nut
30. Lubrication fitting
31. Steering gear arm
32. Steering gear arm plate shim
33. Steering gear arm plate
34. Steering wheel
35. O-ring
36. Steering wheel cap
37. Steering gear arm

1. Install a new upper shaft bushing (14) in the steering gear housing (11) if it was removed.

2. Install a new shaft lower bushing (18) in the housing base (21) if it was removed.

3. Install a new oil seal (22) in the housing base (21).

4. Install the worm wheel shaft (15) and the worm wheel (17) in the housing base (21).



1. Woodruff key
2. Worm wheel shaft
3. Thrust washer

5. Install the thrust washer (3) on the shaft (2), and then install the Woodruff key (1).

6. Install the steering gear arm, washer and nut on the shaft. Tighten the nut to remove end play in the shaft assembly, and then back off to nearest castellation and insert cotter pin.

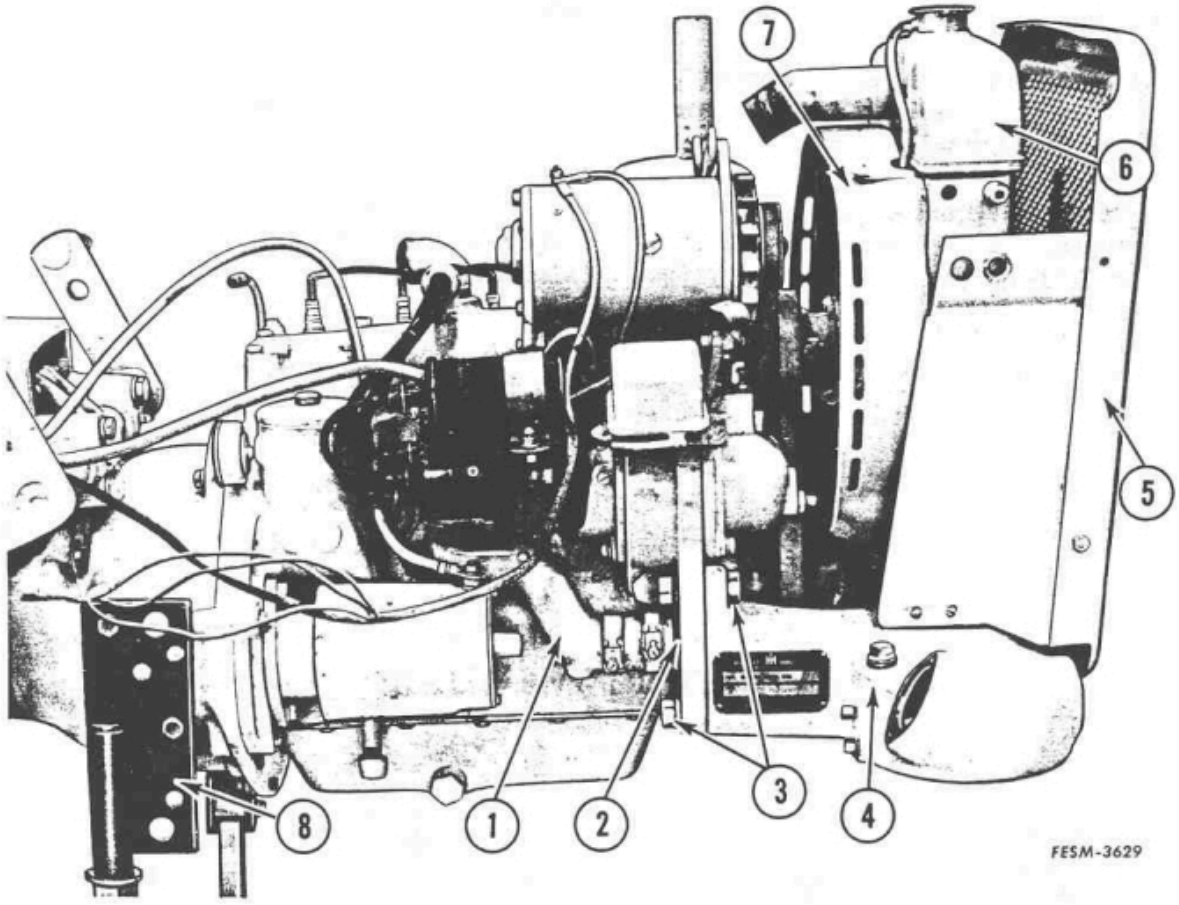
7. Install the bolt and nut in the steering gear arm and tighten securely.

8. Install new thrust washers on the steering worm shaft if they were removed.

9. Install a new oil seal in the steering shaft bearing and install the assembly on the steering shaft.

10. Install the steering shaft support bracket, and then install the Woodruff key and the steering wheel.

Installation



1. Inlet elbow
2. Inlet nipple
3. Cap screw and bolt
4. Steering gear housing assembly
5. Radiator grille
6. Radiator assembly
7. Fan housing
8. Support stands, FES 142-1

1. If the steering gear housing was removed, install it on the tractor as follows:

(a) Using a new gasket, install the radiator (6) and the grille assembly (5) on the housing (4).

(b) Install the housing assembly on the front of the engine and secure with the cap screws and bolts (3).

(c) Install the screws securing the fan housing (7) to the radiator (6).

(d) Install the water inlet nipple (2), and then install and connect the inlet and outlet elbows and hoses.

(e) Install the hood and fuel tank and the headlights.

2. Using a new gasket, install the steering shaft with worm gear in the steering gear housing.

3. Install the cap screws securing the steering shaft bearing to the housing and tighten to 35 ft. lbs. torque.

4. Install the steering shaft support bracket in the steering shaft support arm and secure with the bolt and nut.

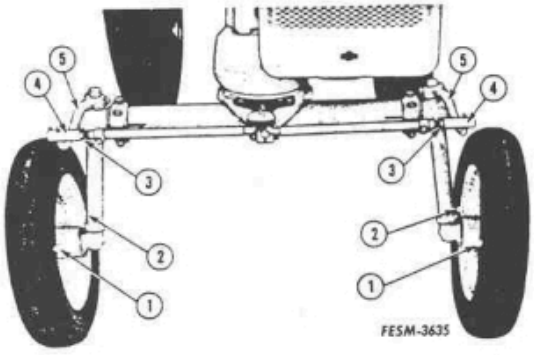
5. Using a new gasket, install the housing base with worm wheel and shaft on the steering housing.

6. Install the cap screws and tighten to 35 ft. lbs. torque. Turn the steering wheel full left and right to check for any binding.

7. Install the front axle. Refer to page 3-7.)

8. Fill the steering gear housing with specified lubricant. (Refer to Operator's Manual.)

ADJUSTING THE TOE-IN



1. Chalk marks
2. Chalk marks
3. Lock nuts
4. Tie rod ends
5. Steering knuckle arms

The front wheels should have 1/4 -inch (± 1/16-inch) toe-in (1/4-inch closer in front than in the rear). To check the toe-in, place chalk marks at points "1" on each rim at hub height and measure the distance between them. Move the tractor forward a distance equal to one-half revolution of the front wheels. The chalk marks will now be at point "2". The measurements between points "1" should be 1/4-inch (±1/16-inch) smaller than at "2".

To adjust the toe-in, disconnect the steering knuckle arms (5) at the tie rod adjustable ends (4). Loosen the lock nuts (3) and turn the tie rod ends (4) in or out as required.

Be sure to make the arm adjustments equal.

Section 4

SPLITTING AND RECOUPLING THE TRACTOR

CONTENTS

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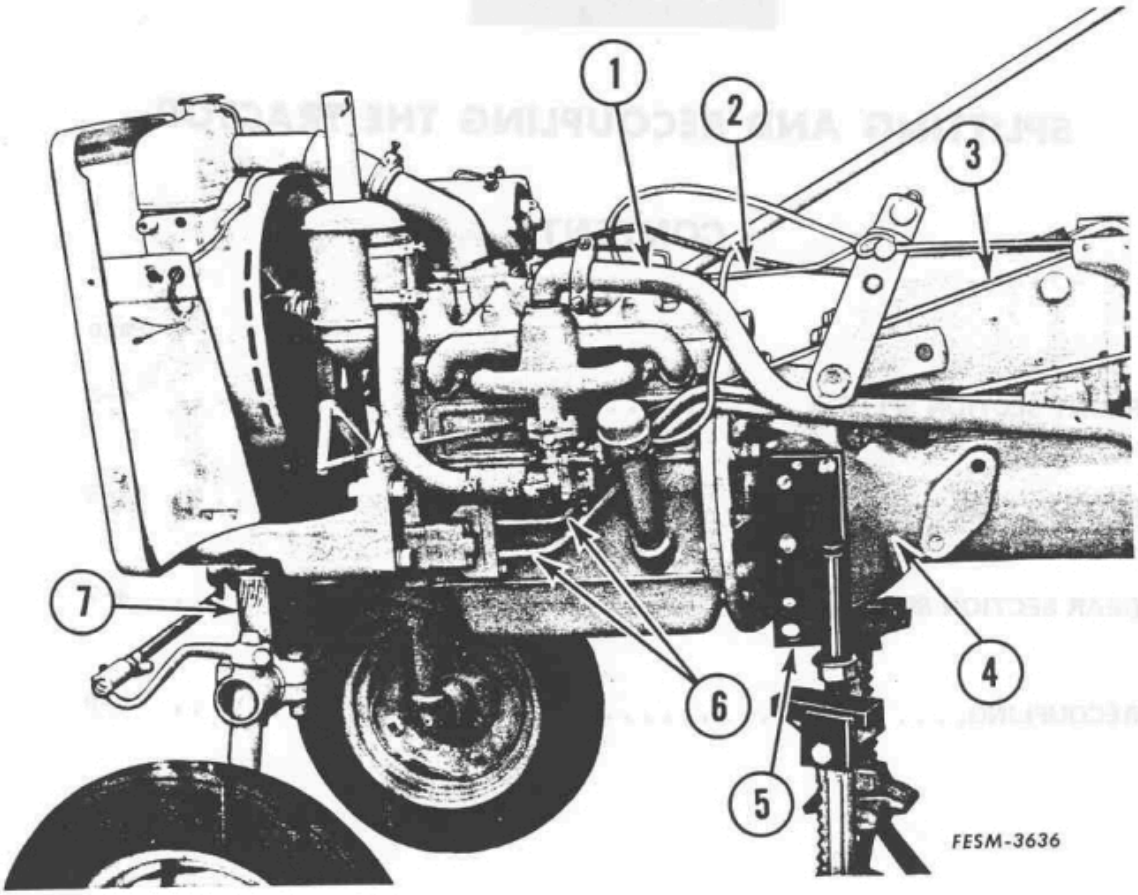
FRONT SECTION SPLIT



1. Exhaust pipe
2. Governor control rod
3. Choke control rod
4. Clutch housing
5. Support stands FES 142-1
6. Manifold tubes
7. Wooden wedges (2)

NOTE: Disconnect the ground wire from the battery.

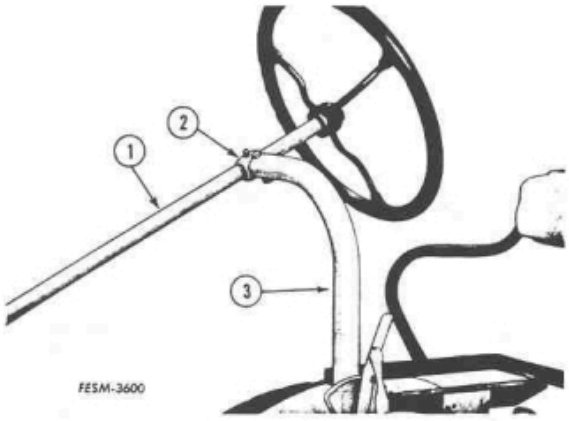
1. Remove the headlights. Disconnect the fuel line from the fuel strainer, and remove the hood and fuel tank.

2. Block the front axle on both sides with wooden wedges (7). Support the rear of the tractor with support stands, FES 142-1 (5).

3. Remove the exhaust pipe (1).

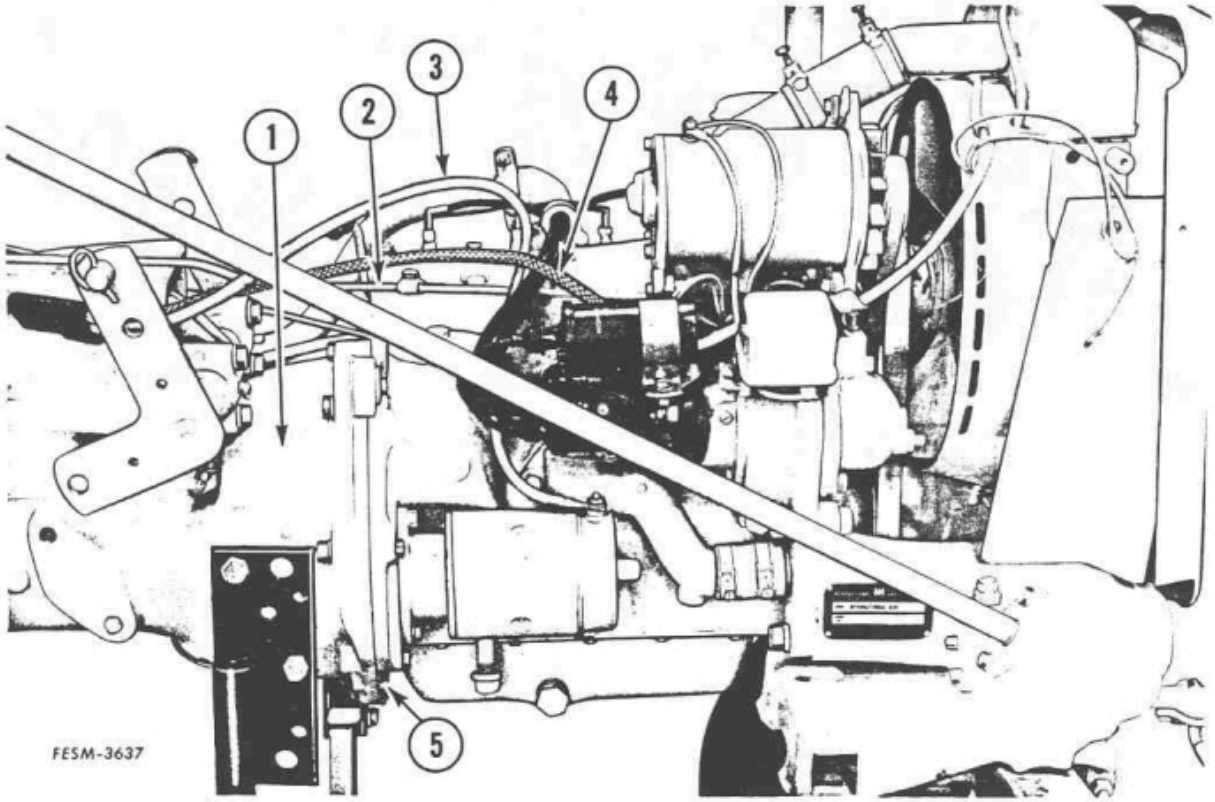
4. Remove the choke control rod (3).

5. Disconnect and remove the hydraulic manifold tubes (6). Be sure to plug the openings in the pump and the hydraulic cylinder assembly to prevent dirt from entering the system.



6. Remove the nut and bolt securing the steering shaft bracket (2) to the steering shaft support arm (3). Remove the bracket from the support arm.

1. Steering shaft
2. Steering shaft support bracket
3. Steering shaft support arm

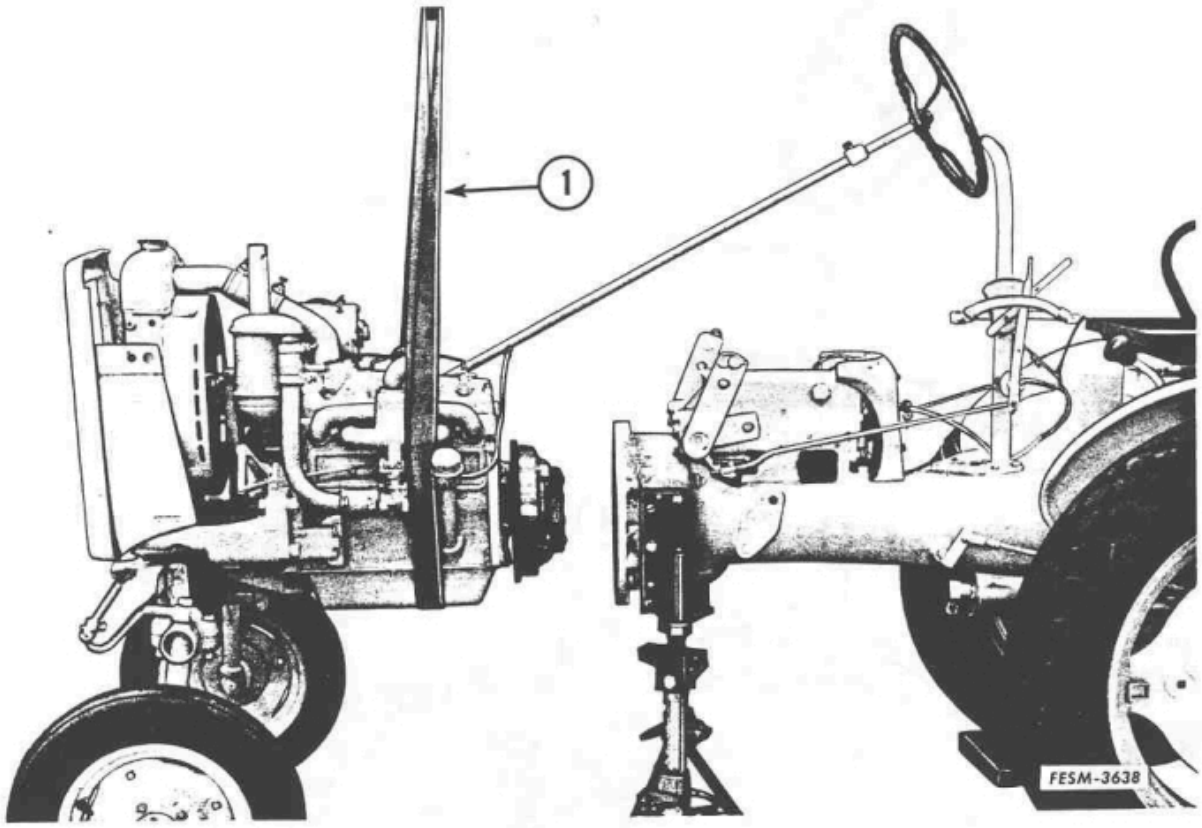


1. Clutch housing
2. Governor control rod
3. Starter motor cable
4. Wiring harness
5. Clutch housing cover

7. Disconnect the wires (3 and 4) to the coil, starter, regulator and lights. Be sure to identify the wires for proper reassembly.

8. Remove the governor control rod (2).

9. Remove the clutch housing cover (5). Remove the nuts and bolts securing the engine to the clutch housing (1).



1. Nylon sling, FES 138

10. Support the engine and split the tractor by moving the engine forward.

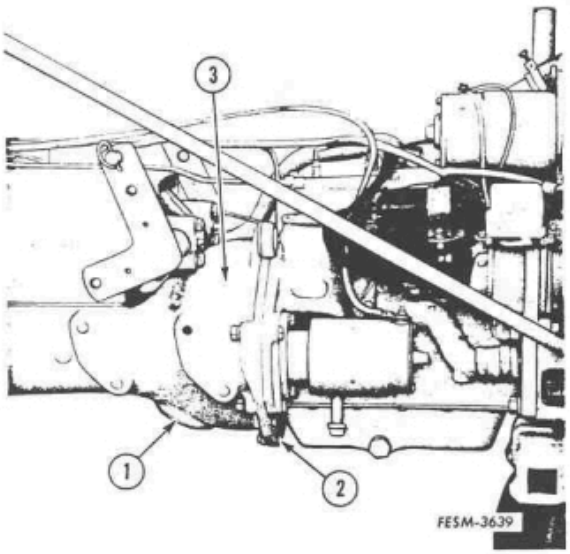
RECOUPLING

1. Remove the hand hole cover in the bottom of the clutch housing.

NOTE: If the clutch assembly was removed, use a pilot shaft to center the clutch driven disc. (Refer to clutch "Installation", Section 5.)

2. Support the engine and recouple the tractor. It may be necessary to reach through the hand hole and guide the spline and clutch shaft through the clutch driven disc and into the flywheel pilot bearing.

3. Install the nuts and bolts and the cap screws in the engine and clutch housing (3). Tighten nuts to 35 ft. lbs. torque and the cap screws to 55 ft. lbs. torque.



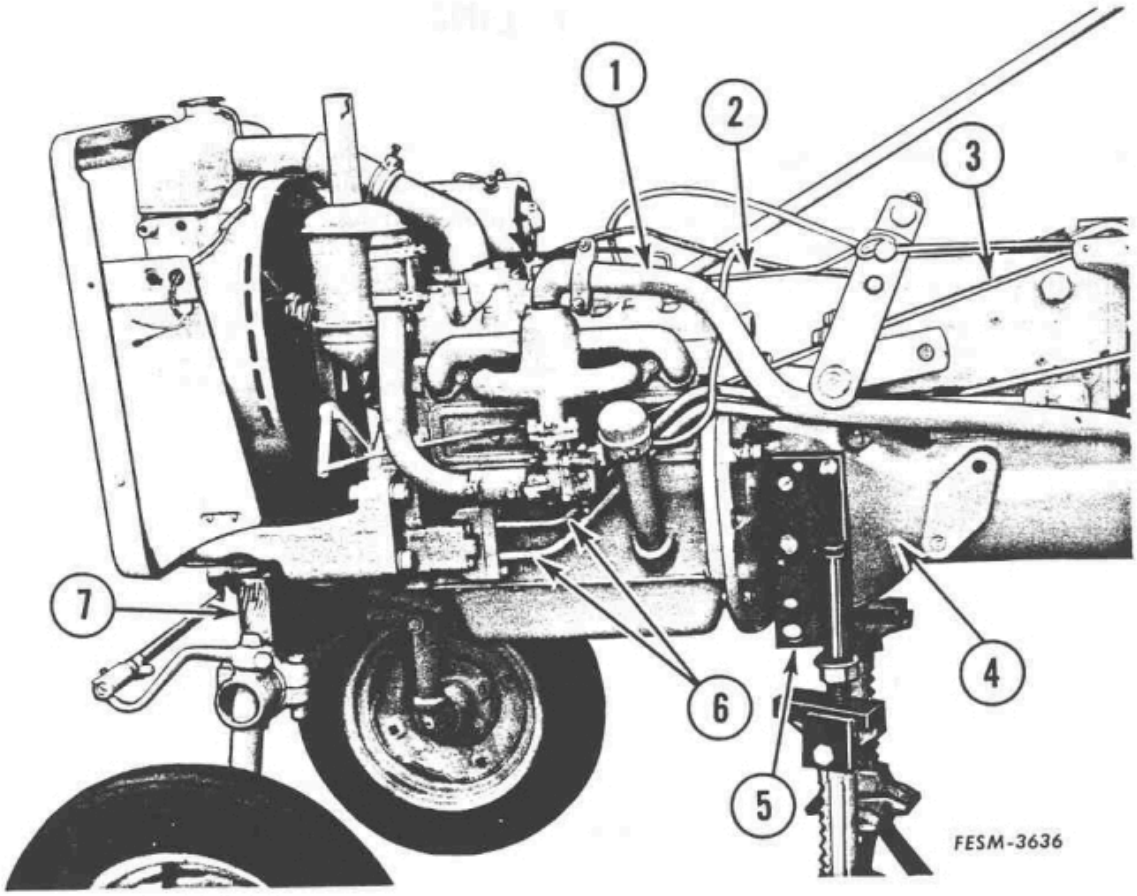
1. Hand hole cover
2. Clutch housing cover
3. Clutch housing

4. Install the clutch housing cover (2) and secure with the nuts and bolts.

5. Install the hand hole cover (1).

6. Connect the wires to the coil, starter, regulator and lights.

7. Install the steering shaft bracket in the shaft support arm and secure with the nut and bolt.



1. Exhaust pipe
2. Governor control rod
3. Choke control rod
4. Clutch housing
5. Support stands FES 142-1
6. Hydraulic oil lines
7. Wooden wedge (2)

8. Using a new gasket and O-rings, install and connect the hydraulic oil lines (6) to the pump and the cylinder block assembly.

9. Install the governor control rod (2).

10. Install the choke control rod (3).

11. Install the exhaust pipe (1).

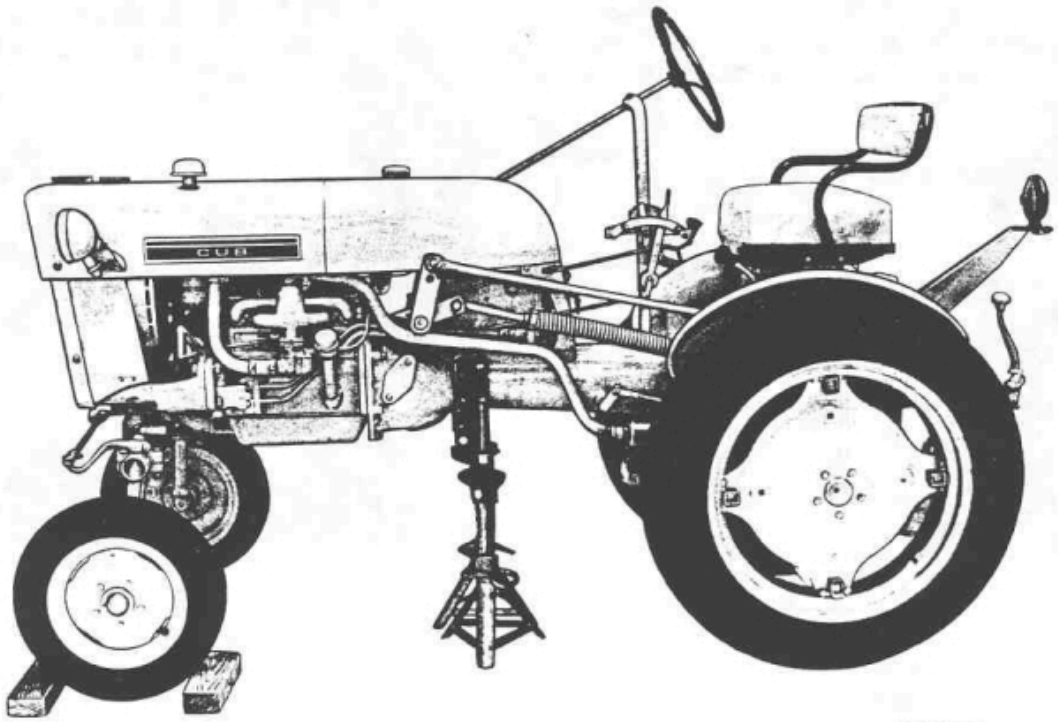
12. Remove the support stands (5) and the wooden wedges (7).

13. Install the hood and fuel tank assembly. Connect the fuel line to the fuel strainer.

14. Install the headlights and connect the wires to them.

15. Connect the battery ground wire to the battery.

REAR SECTION SPLIT



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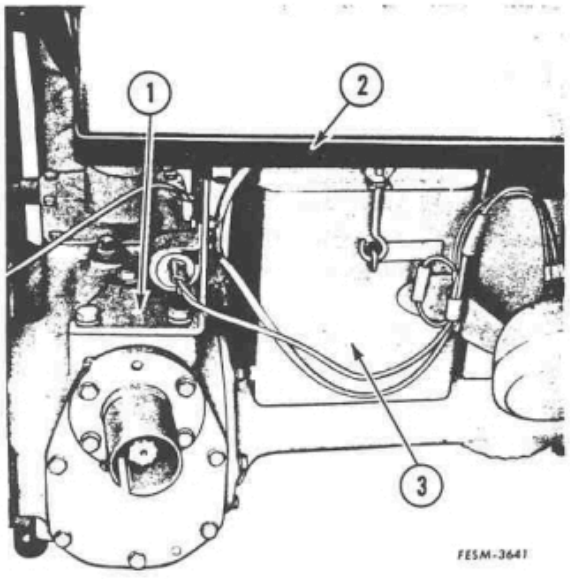


FESM-3641

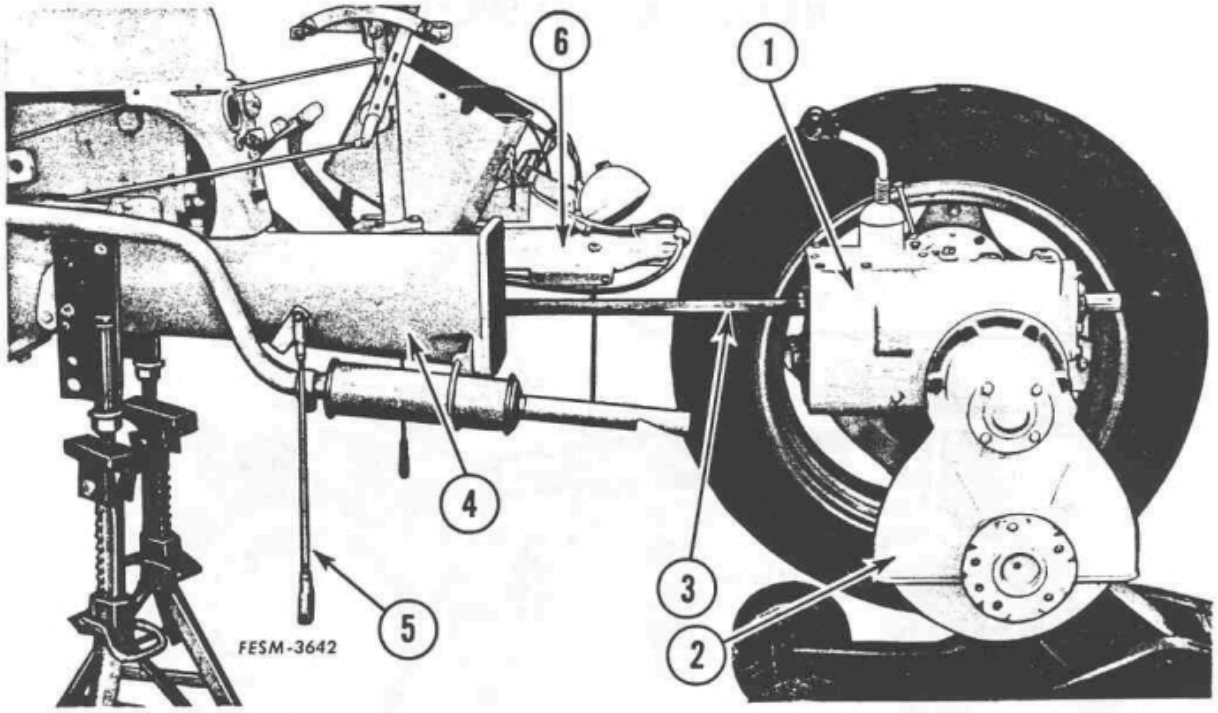
1. Drive wooden wedges between the front axle and the tractor on both sides to stabilize the tractor. Block the front wheels of the tractor so it cannot move.

2. Support the tractor with stands, FES 142-1.

3. Remove the seat supports (1) and seat assembly (2) from the tractor.

4. Remove the battery and battery box (3) from the tractor.

1. Seat support
2. Seat assembly
3. Battery box



1. Transmission case
2. Final drive assembly
3. Spline and clutch shaft
4. Clutch housing
5. Brake operating rod
6. Platform

5. Remove the cap screws securing the transmission case (1) to the platform (6).

6. Disconnect the brake operating rods (5).

7. Remove the cap screws securing the transmission case (1) to the clutch housing (4).

8. Support the transmission (1) and final drive (2), and split the tractor by moving the transmission and final drive rearward. See Illustration with fenders and wheel removed for ease of viewing).

NOTE: Do not depress the clutch pedal while the tractor is split, as this would let the clutch driven disc slip off center.

RECOUPLING

1. Support the transmission (1) and final drive (2) and recouple the tractor. Be sure the transmission spline and clutch shaft (3) goes over the clutch linkage in the clutch housing (4), and the shaft splines mate with the clutch splines. (See illustration with fenders and wheel removed for ease of viewing.)

2. Install the cap screws securing the transmission case (1) to the clutch housing (4). Tighten to 80 ft. lbs. torque.

3. Connect the brake operating rods (5).

4. Install the cap screws securing the transmission case (1) to the platform (6).

5. Install the battery box and the battery.

6. Install the seat supports and seat assembly.

7. Remove the stands and wooden wedges.

8. Check and adjust the brakes and the engine clutch.

Section 5

ENGINE CLUTCH

CONTENTS

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INSPECTION AND REPAIR	5-5
REASSEMBLY	5-7
INSTALLATION	5-8
CLUTCH ADJUSTMENT	5-9

SPECIFICATIONS

Type	Spring loaded, single plate, dry disc
Size - inches	6-1/2
Springs	
Auburn	
Number	3
Free length - inches	1.735
Test length - inches	1.250
Test load - lbs.	129 to 141
Rockford	
Number	6
Free length - inches	1-23/32
Test length - inches	1-1/8
Test load - lbs.	112 to 122
Release lever height - inches	
Auburn	1.877 ± .015
Rockford	1.901 ± .015
Back plate to pressure plate dimension - inch	
Auburn	.341
Rockford	.319
Spline and clutch shaft	
Diameter at clutch pilot bushing end - inch	.621 to .622
Running clearance in pilot bushing - inch	.004 to .006
Drive lug to slot backlash - inch	
Auburn	.002 to .006
Rockford	.004 to .010
Spacer and gauge block number to be used with clutch service tool FES 50	
Auburn	9*
Rockford	10*

* Three 1 inch round blocks are used when adjusting clutch to support pressure plate.

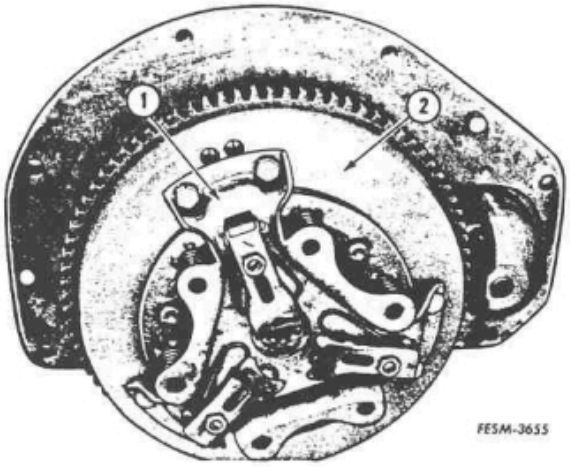
REMOVAL

1. Split the tractor. (Refer to "Front Section Split", Section 4, page 4-2).

2. Remove the cotter pin and the clutch release yoke pivot pin (1) from the clutch housing. Remove the yoke (5) and the clutch release bearing (2) from the clutch housing.

NOTE: Before removing the clutch assembly, be sure to index the clutch to the flywheel for proper reassembly.

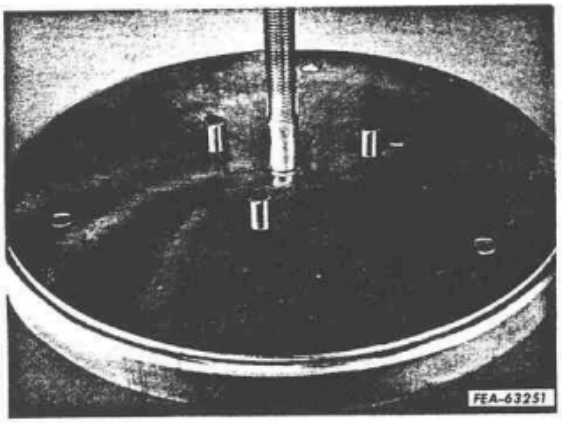
1. Release yoke pivot pin
2. Clutch release bearing and retainer
3. Hand hole cover
4. Transmission spline and clutch shaft
5. Side yokes



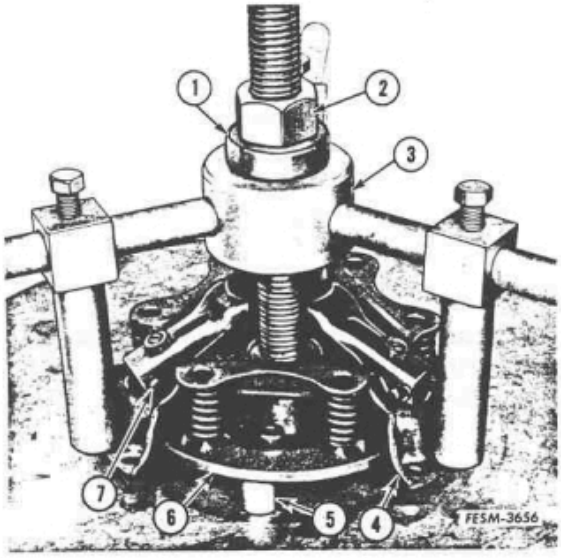
3. Remove the cap screws securing the back plate (1) to the flywheel (2), and remove the clutch assembly.

1. Back plate
2. Flywheel

DISASSEMBLY



1. Place the three, round, one inch blocks on the plate of the clutch service tool, FES 50.



1. Bearing
2. Nut
3. Adjustable bridge
4. Back plate
5. One inch blocks (3)
6. Pressure plate
7. Release lever pin

2. Install the clutch assembly on the service tool so the one inch blocks (5) support the pressure plate (6).

3. Install the adjustable bridge (3), bearing (1) and nut (2) as shown.

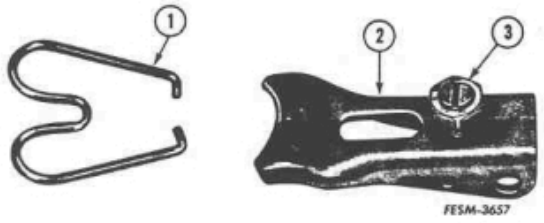
4. Compress the back plate (4) to allow for the removal of the release lever pins (7). Remove the cotter pins and lever pins.

NOTE: Be sure to note the location and position of the lever pins for proper reassembly as the pins are to be installed with the head leading in the direction of rotation.

5. Loosen the lock nuts and remove the adjusting screws from the release levers.

6. Release the adjustable bridge and remove the back plate and pressure springs.

7. If it is necessary to remove the release levers, push the levers toward the center of the clutch to disengage them from the spring clips.



8. Remove the lever springs (1), if necessary, from the release levers (2).

1. Lever spring
2. Release lever
3. Adjusting screw and lock nut

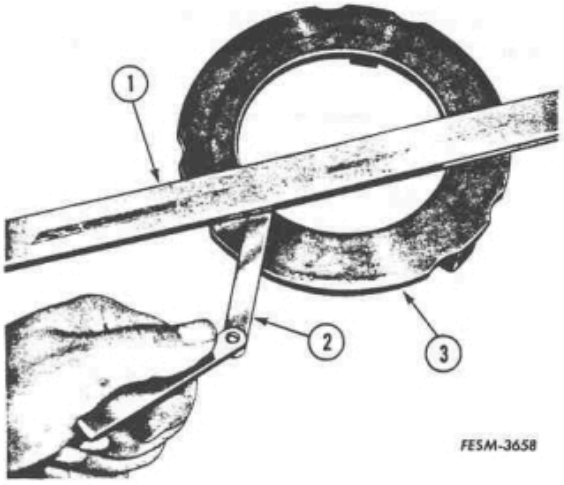
INSPECTION AND REPAIR

1. Clean all parts thoroughly before inspection.

2. Inspect the release levers for wear at the tips where they contact the release bearing and at the pin holes. Check for weak or broken lever springs and worn lever adjusting screws. Although available for service individually, it is recommended that release levers, lever springs and pins be replaced as a complete set.

3. Replace the back plate if bent or warped, or if the drive lug slots or the splines in the hub are excessively worn.

4. Check the free length of the clutch pressure springs and their tension at the test length shown in "SPECIFICATIONS." If the springs do not meet specifications, replace them with new ones. It is recommended that pressure springs be replaced as a complete set.

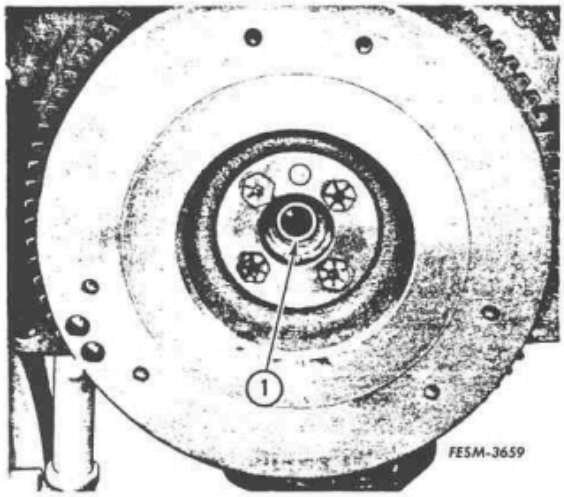


1. Straight edge
2. .006 inch feeler gauge
3. Pressure plate

5. Place a straight-edge (1) across the pressure plate (3) and check to see if the plate is warped. If a .006 inch feeler gauge (2) can be inserted anywhere between the straight-edge and the plate, the plate should be replaced. Check the plate in three or four different spots.

6. Inspect the driven disc and replace facings if they are badly worn, glazed or oil soaked. When riveting new linings be sure the rivets are properly countersunk. Replace the entire driven disc if it is warped, or the hub splines are excessively worn or damaged.

7. Inspect the clutch release bearing and if badly worn or grooved, replace with a new one. Inspect the clutch release yokes and pivot pin for wear, and replace as necessary.



1. Pilot bearing

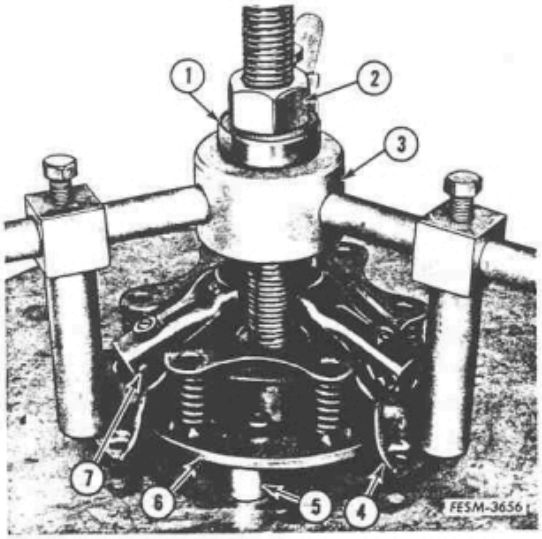
8. Inspect the pilot bearing (1) in the crankshaft. Looseness of this bearing is one cause of clutch misalignment. If worn, replace the bearing (be sure bushing is clean and lightly lubricated).

9. Inspect the face of the flywheel for grooves, ridges, scores, heat cracks and burned spots caused by overheating and projecting rivets. Also check for warpage. Scoring and slight burned spots can be removed with emery cloth, starting with coarse and finishing with fine grit. Excessively grooved or cracked flywheels should be replaced.

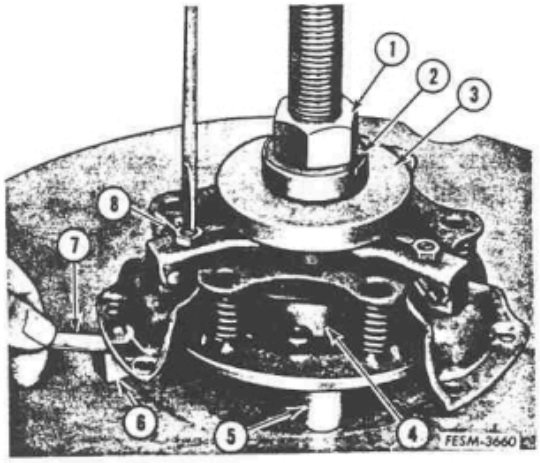
10. Remove any burrs from offsets of the back plate to insure accurate adjustment.

REASSEMBLY

1. Install the lever springs in the release levers if they were removed.



1. Bearing
2. Nut
3. Adjustable bridge
4. Back plate
5. One inch blocks (3)
6. Pressure plate
7. Release lever pin



2. Install the release levers and springs on the back plate.

3. Install the clutch assembly on the service tool so the one inch blocks support the pressure plate.

4. Install the adjustable bridge (3), bearing (1) and nut (2). Compress the back plate (4) and install the lever pins (7) and cotter pins.

NOTE: Be sure the lever pins are installed with the head of the pin leading in the direction of rotation.

5. Remove the adjustable bridge.

6. Select the specified spacer and gauge block number for the particular clutch being adjusted. (Refer to "Specifications", page 5-2).

7. Place the spacer (4) down over the bolt of the service tool plate.

8. Install the adapter (3), bearing (2) and nut (1). Tighten the nut until the adapter (3) bottoms on the spacer (4). This will set the release levers to their specified height.

9. Place the specified gauge block (6) between the tool plate and back plate in the area below one of the release levers.

1. Nut
2. Bearing
3. Adapter
4. Spacer
5. One inch blocks
6. Gauge block
7. .002 inch feeler gauge
8. Adjusting screw

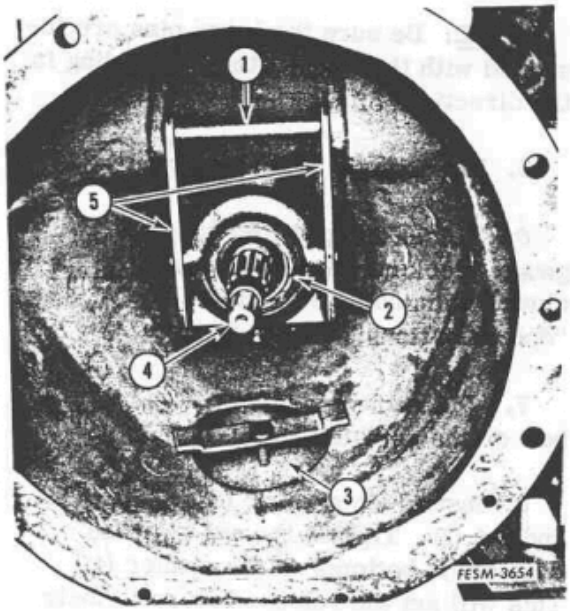
10. Install the adjusting screws and lock nuts in the release levers.

11. Screw the adjusting screw in until the space between the gauge block and back plate is close at each lever position.

12. For final adjustment, adjust the screws (8) until there is approximately .002 inch clearance (7) between the back plate and gauge block (6). Adjust at each release lever, and tighten the lock nuts securely.

13. Remove the nut, bearing, adapter and spacer.

INSTALLATION



1. Install the clutch release yokes (5) and clutch release bearing (2) in the clutch housing. Install the pivot pin (1) and secure with the cotter pin. Lubricate the release bearing with the recommended lubricant (refer to Operator's Manual).

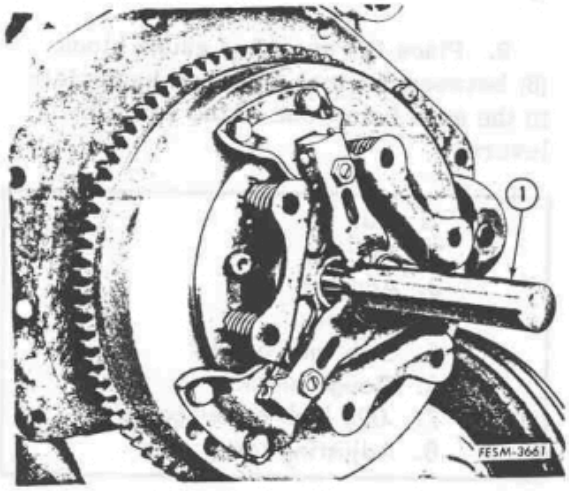
1. Release yoke pivot pin
2. Clutch release bearing and retainer
3. Hand hole cover
4. Transmission spline and clutch shaft
5. Side yokes

2. Install the clutch assembly as follows:

(a) Use a pilot shaft (1) to center the clutch driven disc.

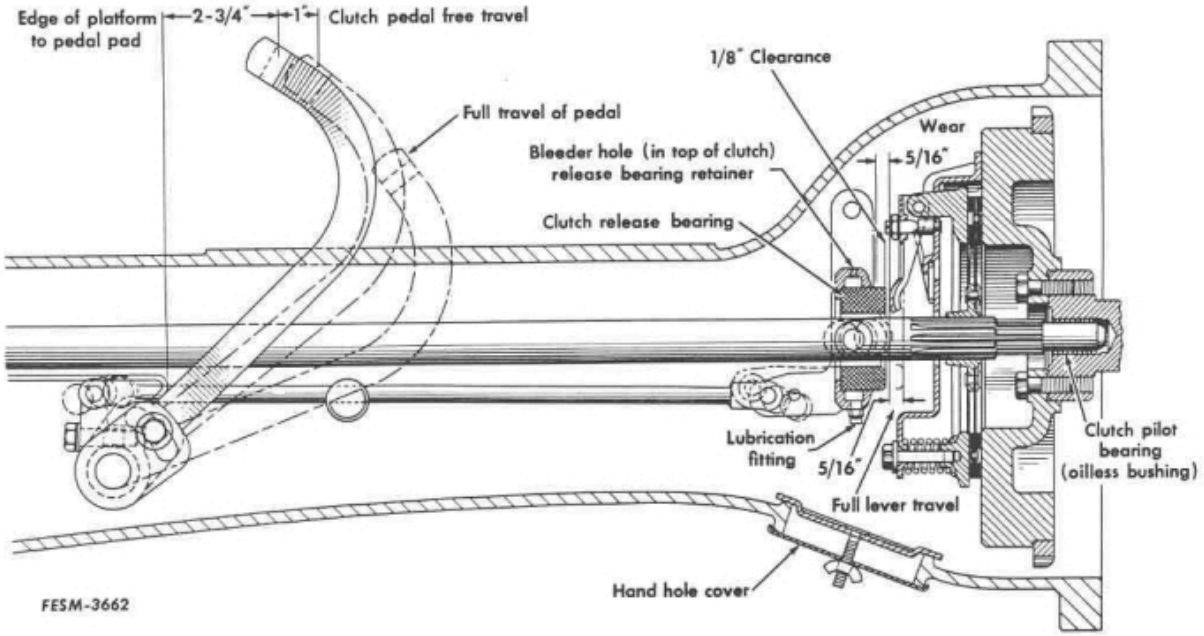
(b) Install the pressure plate assembly on the flywheel being sure to position the assembly as it was indexed before removal. Install the cap screws and tighten to 20 ft. lbs. torque.

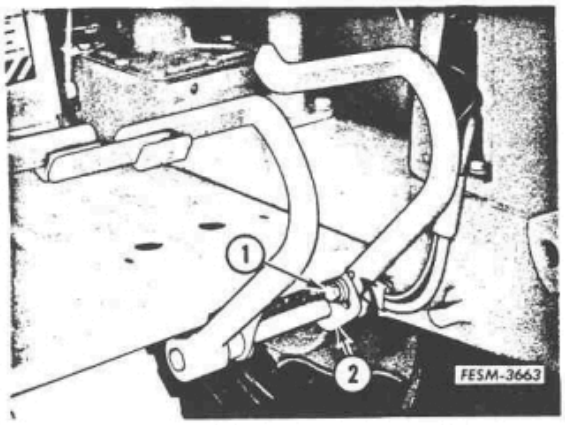
3. Recouple the tractor. (Refer to "Front Section Split", Section 4, page 4-2).



1. Pilot shaft

CLUTCH ADJUSTMENT





1. Cap screw
2. Slotted lever

As a result of normal clutch facing wear, the free travel between the clutch release levers and the release bearing is reduced. Lack of clearance causes overheating of the clutch, loss of power and early replacement of clutch facing. It is important that a clearance of approximately 1/8-inch be maintained between the engine clutch release bearing and the engine clutch release levers.

The specified free travel is obtained by loosening the cap screw (1) on the outside of the clutch pedal, and rotating the slotted lever (2) counterclockwise to a position which will give 1-inch free pedal travel; then retighten the cap screw.

Section 6

TRANSMISSION AND DIFFERENTIAL

CONTENTS

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Differential	6-5
Transmission	6-6
INSPECTION AND REPAIR	6-7
REASSEMBLY AND INSTALLATION	6-8

SPECIFICATIONS

Transmission

Type	Selective, sliding spur gears
Gears forward	3
Gears reverse	1

Countershaft gears (no. teeth)

Bevel pinion	10
Reverse speed gear	35
1st speed gear	39
2nd speed gear	36
3rd speed gear	26

Transmission - Continued

Countershaft spacer lengths

Between front bearing and 3rd speed driven gear - inch	.848 to .852 (beveled edge to bearing)
Between 3rd speed driven gear and 2nd speed driven gear - inches	1.310 to 1.314
Between 2nd speed driven gear and 1st speed driven gear - inch	.310 to .314
Between 1st speed driven gear and reverse driven gear - inch	.686 to .690
Between reverse driven gear and rear bearing - inch	.690 to .694 (beveled edge to bearing)

Countershaft OD

For front bearing - inch	.7873 to .7876
For rear bearing - inches	1.1803 to 1.1808

Spline and clutch shaft gears (no. teeth)

1st and reverse speed sliding gear	13
2nd and 3rd speed sliding gear	16 and 26

Spline and clutch shaft OD

For front bearing - inch	.9842 to .9846
For rear bearing - inch	.8095 to .8099

Reverse idler shaft OD - inch	.610 to .611
Reverse idler gear bushing (installed and reamed) ID - inch	.6120 to .6130

Bearings

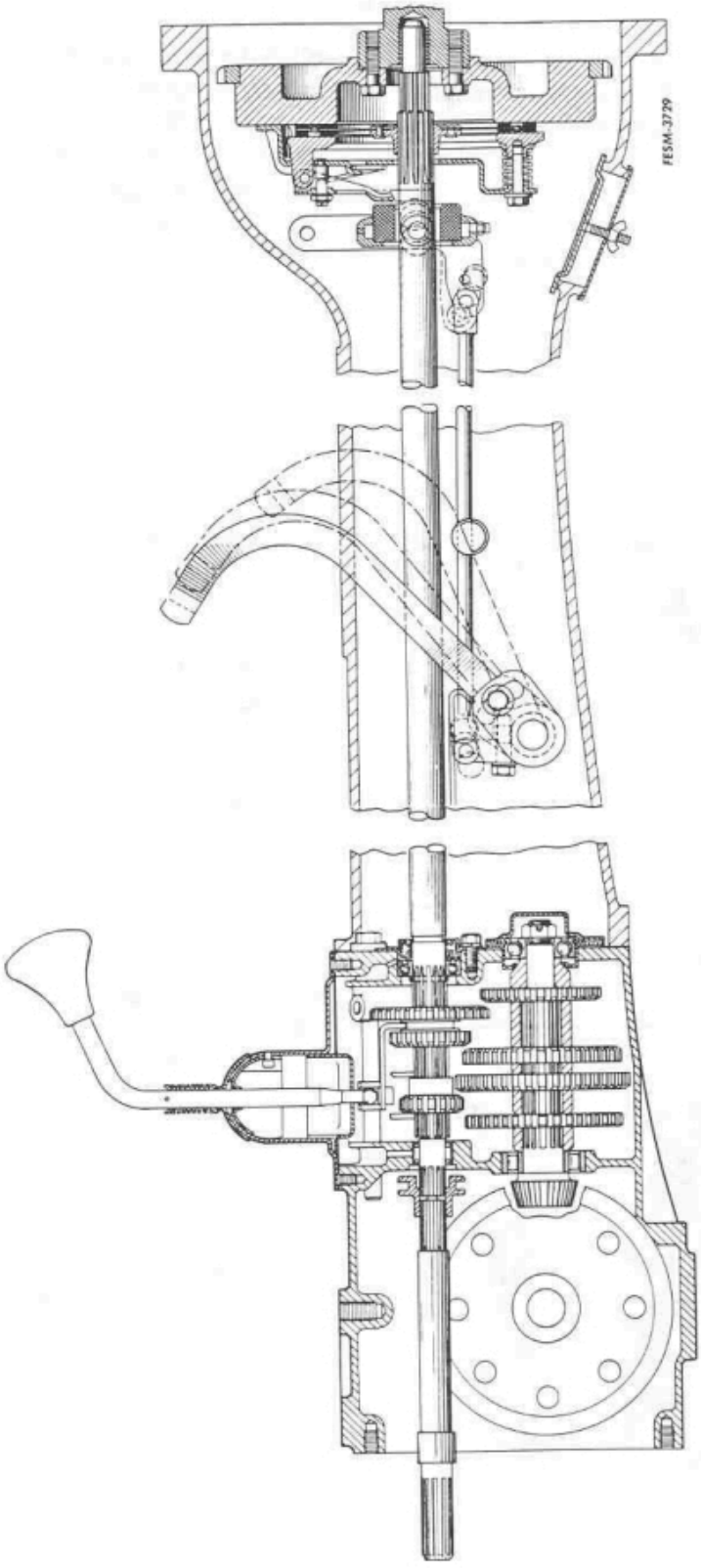
Countershaft	Ball - front Roller - rear
Spline and clutch shaft	Ball - front Needle - rear

Special torques

Transmission countershaft nut	90 ft. lbs.

Differential

Type	Bevel gears and pinions
Number of pinions	2 (10 teeth)
Number of side gears	2 (16 teeth)
Bearings (2)	Tapered roller
Bevel pinion and drive gear backlash - inch	.003 to .005
Bevel pinion location	Integral part of countershaft
Drive gear location	In transmission case
Ratio (bevel pinion to drive gear)	10 to 46
Differential bearing pre-load (rolling torque)	1 to 8 in. lbs.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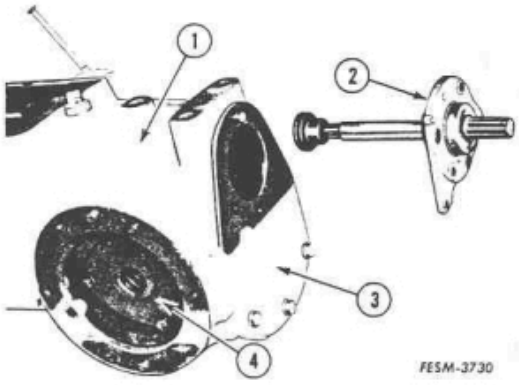
GENERAL

Complete service of the transmission requires splitting of the tractor, removal of the final drive assemblies and removal of the power take-off assembly and the differential.

The differential can be removed and replaced without disassembling the transmission, however the transmission countershaft must be removed when checking pre-load of the differential carrier bearings. The transmission and differential are therefore covered together.

REMOVAL



1. Transmission case
2. PTO assembly
3. PTO adapter plate
4. Differential bearing retainer

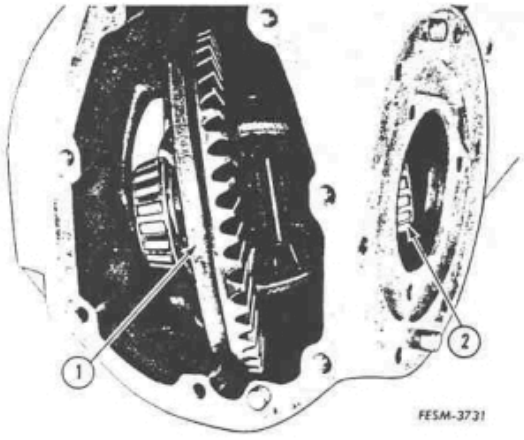
1. Remove the drawbar or the fast hitch assembly (if equipped).

2. Split the tractor. Refer to "Rear Section Split", Section 4, page 4-7.

3. Remove the final drive assemblies, and remove the differential shaft housing from the transmission case.

4. If equipped with PTO, remove the PTO adapter plate (3) and the PTO assembly (2) from the transmission case (1). If not equipped with PTO, remove the transmission rear cover plate.

5. Remove the differential bearing retainers (4) and shims. Be sure to keep the shims with each retainer and identified for each side.

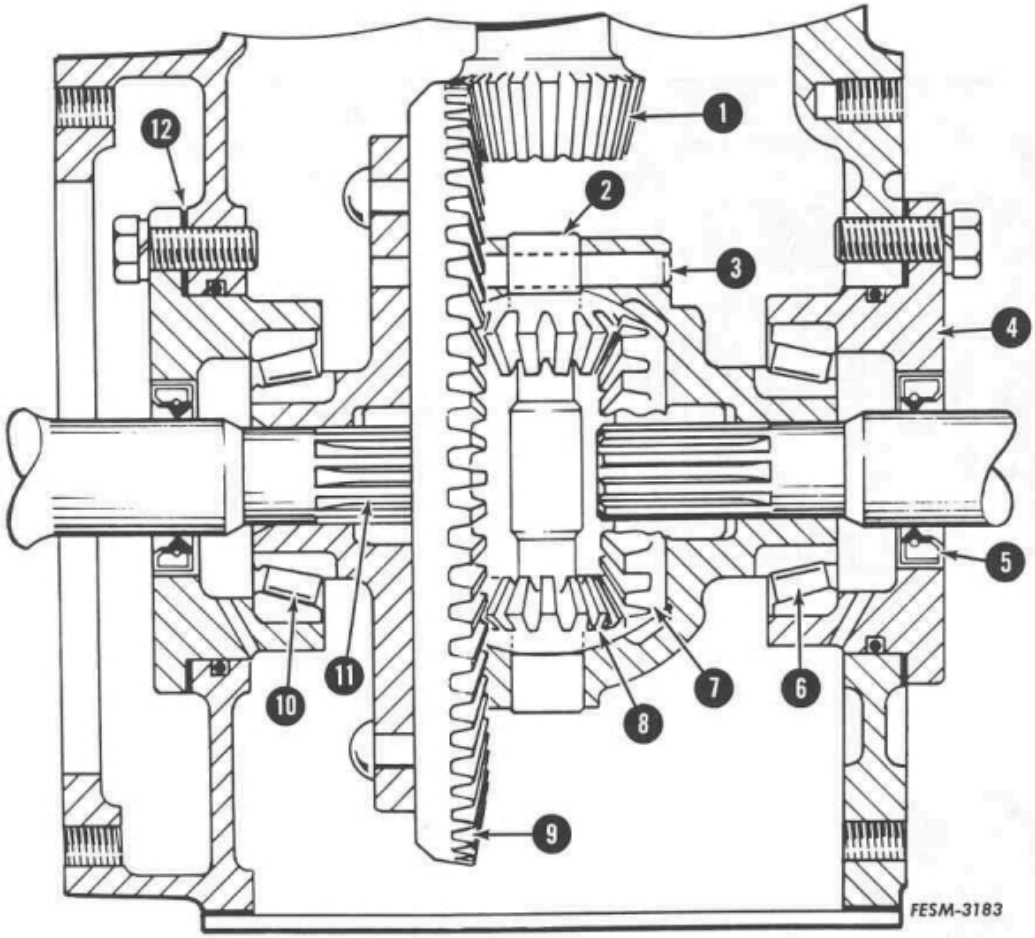


6. Turn the differential (1) into position as shown and remove it from the transmission case. If the assembly will not clear the side of the case, it will be necessary to remove the R.H. bearing cone (2).

1. Differential assembly
2. R.H. bearing cone

DISASSEMBLY

Differential



1. Bevel pinion
2. Pinion shaft
3. Lock pin
4. Bearing retainer
5. Oil seal
6. R.H.bearing
7. Side gear (2)
8. Pinion (2)
9. Drive gear
10. L.H. bearing
11. Differential shaft
12. Shims

1. Drive out the pinion shaft lock pin (3) and remove the pinion shaft (2).

2. Remove the pinion gears (8) and side gears (7).

3. If the differential drive gear (9) requires separate replacement, press out the eight retaining rivets.

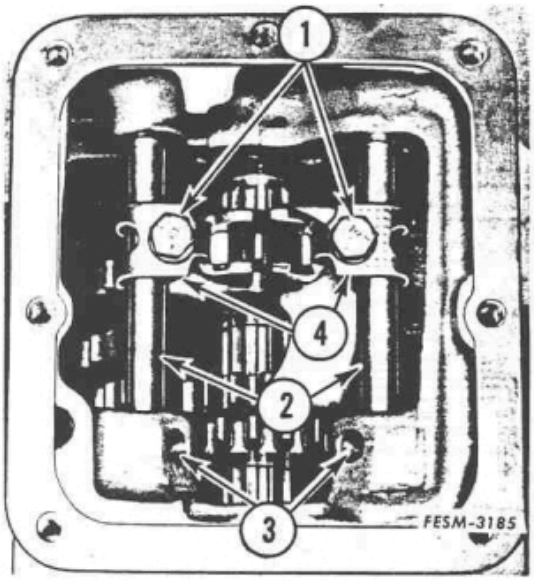
4. Remove the bearing cones (6 and 10) from the differential carrier if they are to be replaced.

5. Remove the bearing cups from the bearing retainers if replacement is necessary.

6. Remove the oil seals (5) from the bearing retainers (4).

Transmission

1. Remove the differential assembly as previously described on page 6-5.

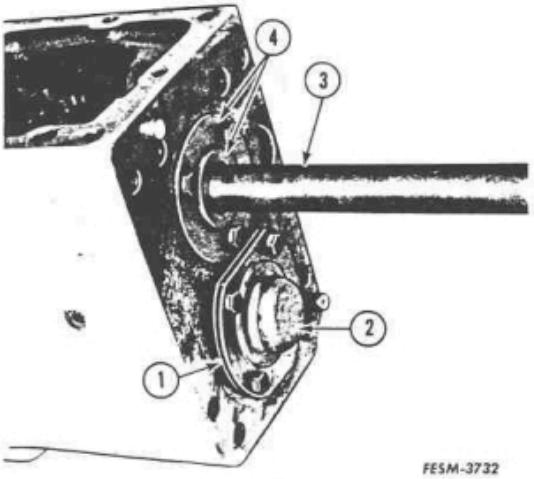


2. Remove the gear shift assembly from the transmission case.

3. Remove the gear shift forks (4) and rods (2) by removing the shifter fork set screws (1) and driving the rods forward out of the case.

CAUTION: Cover the shifter poppet ball holes (3) to prevent the balls and springs from flying out as the rods are removed.

1. Shifter fork set screws
2. Shifter rods
3. Poppet ball holes
4. Shifter forks



1. Countershaft bearing retainer and shims
2. Bearing retainer cap
3. Spline and clutch shaft
4. Bearing retainer and oil seal

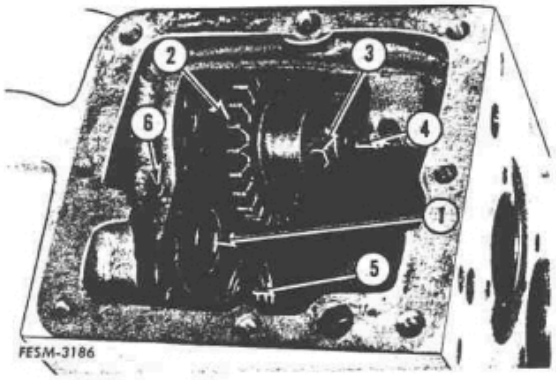
4. Remove the countershaft bearing retainer cap (2), and remove the cotter pin from the nut.

5. Shift the transmission into two gear speeds to lock the transmission, then remove the countershaft nut.

6. Remove the spline and clutch shaft bearing retainer and oil seal (4). Remove the shaft (3) and gears from the case. Remove the bearing retaining ring and remove the bearing from the shaft.

7. Remove the countershaft bearing retainer and shims (1). Save the shims for use in reassembly.

8. Move the countershaft rearward and out of the case as the gears and spacers are removed. Note the sequence of spacers and gears for reassembly.



9. To remove the reverse idler shaft and gear assembly, remove the set screw (3) and remove the shaft, reverse idler gear assembly (2) and expansion plug (4). Press the bushing out of the reverse idler gear if the bushing is to be replaced.

10. Remove the bearings (1 and 5) from the transmission case if they are to be replaced.

1. Spline and clutch shaft rear bearing
2. Reverse idler gear assembly
3. Set screw
4. Expansion plug
5. Countershaft rear bearing
6. Oil passage

INSPECTION AND REPAIR

1. Wash all parts in cleaning solvent and dry with compressed air. Do not spin bearings.

2. Check all bearings for looseness, wear, roughness, pitting and scoring, and replace if necessary.

3. Check the gears and shafts for wear and burrs. Remove any burrs with a fine stone.

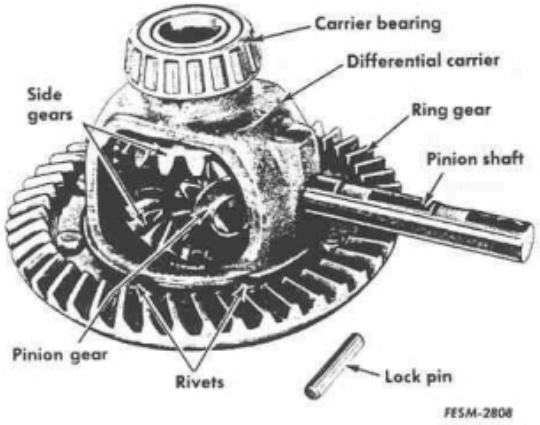
4. Inspect the housing for cracks, restricted oil passages or raised places on its machine faces. Smooth off raised places with a file.

5. Be sure to install new oil seals, gaskets and O-rings.

6. Thoroughly lubricate all parts with Hy-Tran before reassembly.

REASSEMBLY AND INSTALLATION

1. Install new rear bearings (1 and 5) in the transmission case if they were removed. Be sure the spline and clutch shaft rear bearing (1) is installed with its oil hole aligned with the oil passage (6) in the transmission case. (Refer to illustration on page 6-7.)



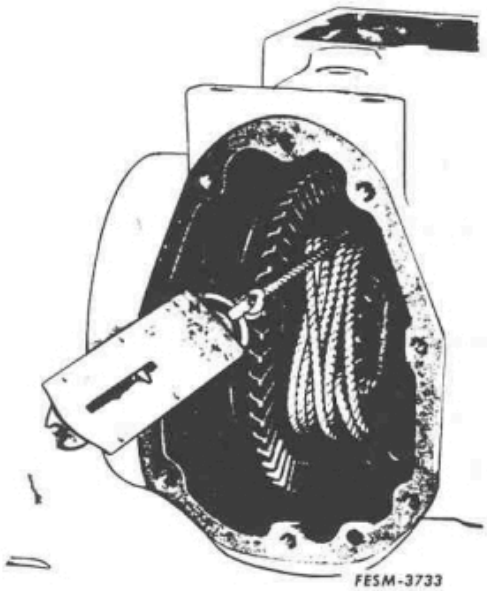
2. Assemble the side gears and the pinion gears in the differential carrier.

3. Install the pinion shaft and drive the pinion shaft lock pin into place.

4. Install the differential assembly in the transmission case.

5. Press the R.H. bearing on the differential carrier if it was removed during disassembly.

6. Install the bearing retainers and shims. Install the cap screws and tighten to 45 ft. lbs. torque.

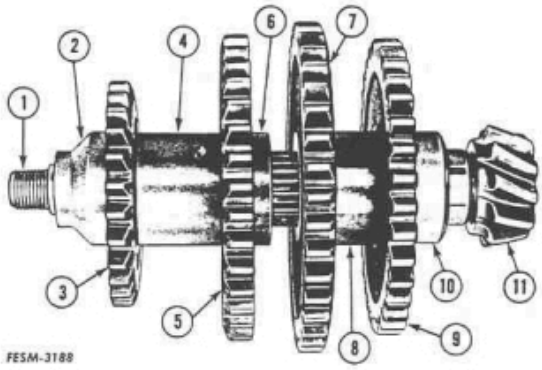


7. Check bearing preload before installing the transmission countershaft. Preload is correct when a steady pull of one to eight pounds is necessary to rotate the differential assembly.

8. Add or remove an equal amount of shims on both bearing retainers to adjust for specified preload.

9. Remove the differential assembly in order to install the countershaft. Be sure to keep the shims with each retainer and identified for each side.

10. Install the transmission countershaft, spacers, gears, front bearing, bearing retainer and shims and the countershaft nut. Do not torque nut at this time. Refer to Specifications for spacer lengths. Be sure to install a new O-ring and gasket.



FESM-3188

1. Countershaft
2. Spacer
3. 3rd speed gear
4. Spacer
5. 2nd speed gear
6. Spacer
7. 1st speed gear
8. Spacer
9. Reverse speed gear
10. Spacer
11. Bevel pinion

11. Install the differential assembly in the transmission case. The drive gear must be on the left with the teeth facing right.

12. Install the R.H. carrier bearing if it was removed.

13. Keeping pre-load shim pack correct as previously established, install the bearing retainers, new oil seals and new O-rings. Tighten the cap screws to 35 ft. lbs. torque.

14. Check the backlash, between the drive gear and countershaft bevel pinion, and the gear teeth bearing pattern as follows:

(a) Apply a thin coat of red lead or prussian blue to the bevel pinion teeth faces, then rotate the gears by hand and observe the bearing pattern.

Some deflection will occur under load. Allowance is made in gear design to prevent concentration of load on tooth edges.

(b) Hand testing and very light loads should provide a pattern as shown in Figure "B". When load and deflection increases the pattern will progress as in Figure "A".

(c) The desirable (no load) pattern in Figure "B" is the result of adjusting the differential drive gear lateral position to the specified range of .003" to .005" backlash.

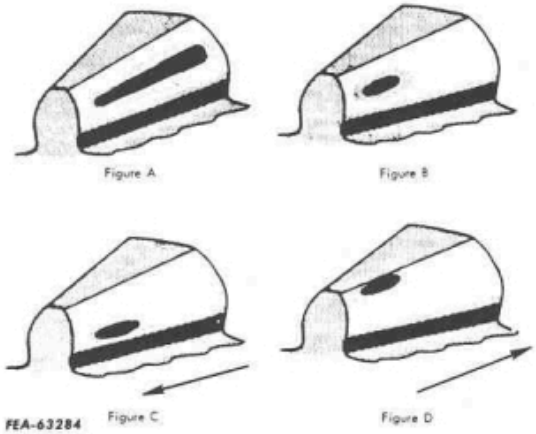
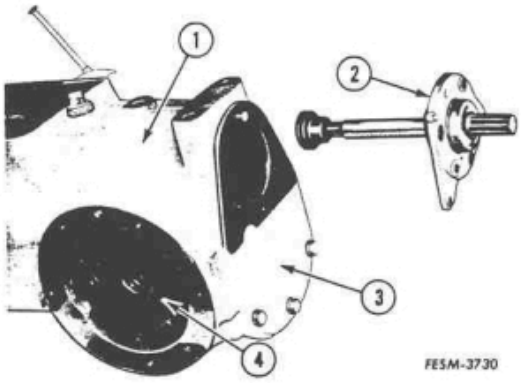


Figure A
Figure B
Figure C
Figure D
FEA-63284

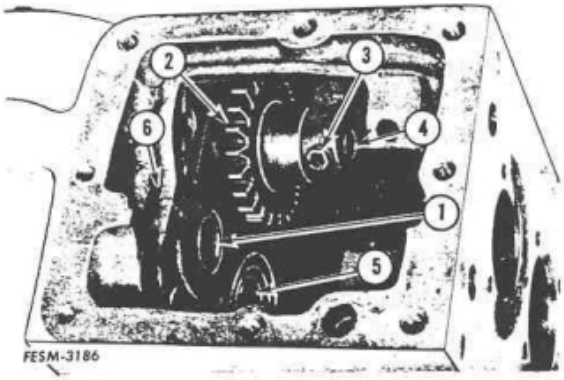
(d) Adjust the drive gear lateral position by removing shims from one side and installing the shims removed on the opposite side.

NOTE: Do not add or remove shims to change the total amount of shims in the previously established shim pack as this will change the bearing preload.

(e) Tooth bearing position from the root to the crown of the tooth is controlled by lateral position of the bevel pinion.



1. Transmission case
2. PTO assembly
3. PTO adapter plate
4. Differential bearing retainer



(1) If low tooth bearing position on the bevel pinion is indicated (as shown in Figure "C"), the pinion must be adjusted towards the drive gear.

(2) If high tooth bearing position on the bevel pinion is indicated (as shown in Figure "D"), the pinion must be adjusted away from the drive gear.

(f) Adjust the bevel pinion by adding or removing shims between the bearing retainer and the transmission case.

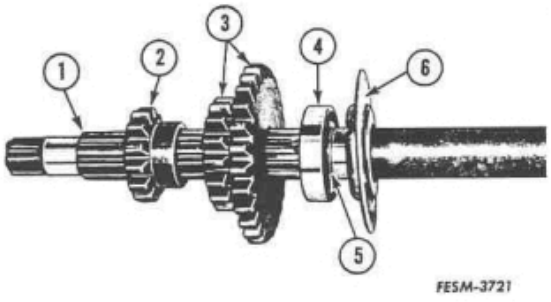
NOTE: If it is necessary to move the bevel pinion in or out to correct "Root-to-crown" bearing, the drive gear must also be moved laterally to maintain the specified backlash.

15. If equipped with PTO, use new gaskets and install the PTO adapter plate (3) and the PTO assembly (2). Be sure the PTO shifter lever and fork is in the shifter clutch groove. Tighten the cap screws to 35 ft. lbs. torque.

16. If the reverse idler bushing is to be replaced, press the bushing into the gear until the edge is flush with the gear face. Ream the bushing to the specified I.D. of .612 to .613 inch.

17. Install the reverse idler shaft and idler gear assembly (2) in the case. Install the set screw (3) and tighten securely. Be sure to install a new expansion plug (4).

1. Spline and clutch shaft rear bearing
2. Reverse idler gear assembly
3. Set screw
4. Expansion plug
5. Countershaft rear bearing
6. Oil passage



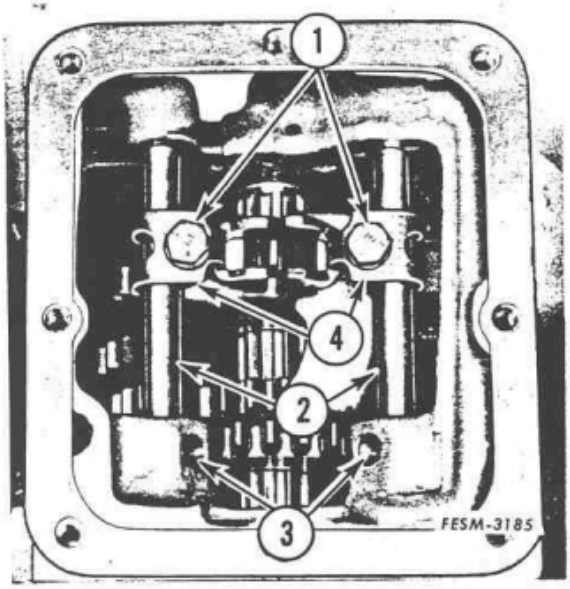
1. Spline and clutch shaft
2. First and reverse speed sliding gear
3. Second and third speed sliding gear
4. Bearing
5. Retaining ring
6. Oil seal and bearing retainer assembly

18. Install the bearing (4) on the spline and clutch shaft (1) and secure with the retaining ring (5). Install the shaft, bearing and gears (2 and 3) in the transmission case.

19. Install a new shaft oil seal and retainer (6) and gasket. Tighten the cap screws to 20 ft. lbs. torque.

20. Shift the transmission into two gear speeds to lock the transmission. Tighten the countershaft nut to 80 ft. lbs. torque.

21. Install the cotter pin in the nut, and using a new gasket install the bearing retainer cap. Tighten the cap screws to 35 ft. lbs. torque.



1. Shifter fork set screws
2. Shifter rods
3. Poppet ball holes
4. Shifter forks

22. Install the shift poppet balls and springs in their bores (3).

23. Depress the balls and install the shifter rods (2) and forks (4). Lock the forks in place with the set screws (1) and tighten securely.

24. Install new expansion plugs in the front shifter rod bores.

25. Use a new gasket and install the gear shift assembly on the transmission case.

26. Install the differential shaft housing and the final drive assemblies.

27. Recouple the tractor. Refer to Section 4.

28. Install the fast hitch assembly (if equipped) or the drawbar.

Section 6A

POWER TAKE-OFF AND BELT PULLEY

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SPECIFICATIONS 6A-1

BELT PULLEY

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POWER TAKE–OFF

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SPECIFICATIONS

Belt Pulley

Drive	Spline coupled to power take-off
Bevel gear backlash - inch	.003 to .005

Pulley drive shaft (with pinion) diameters

Inner bearing location - inches	1.1076 to 1.1080
Outer bearing location - inch	.9842 to .9846
Bearings	Ball

Power Take-Off

Type	Transmission driven
Speed	Same as engine speed

Bearings

Rear	Ball
Front (pilots into transmission spline and clutch shaft)	Bronze bushing
ID after pressing into shaft - inch	.3747 to .3757

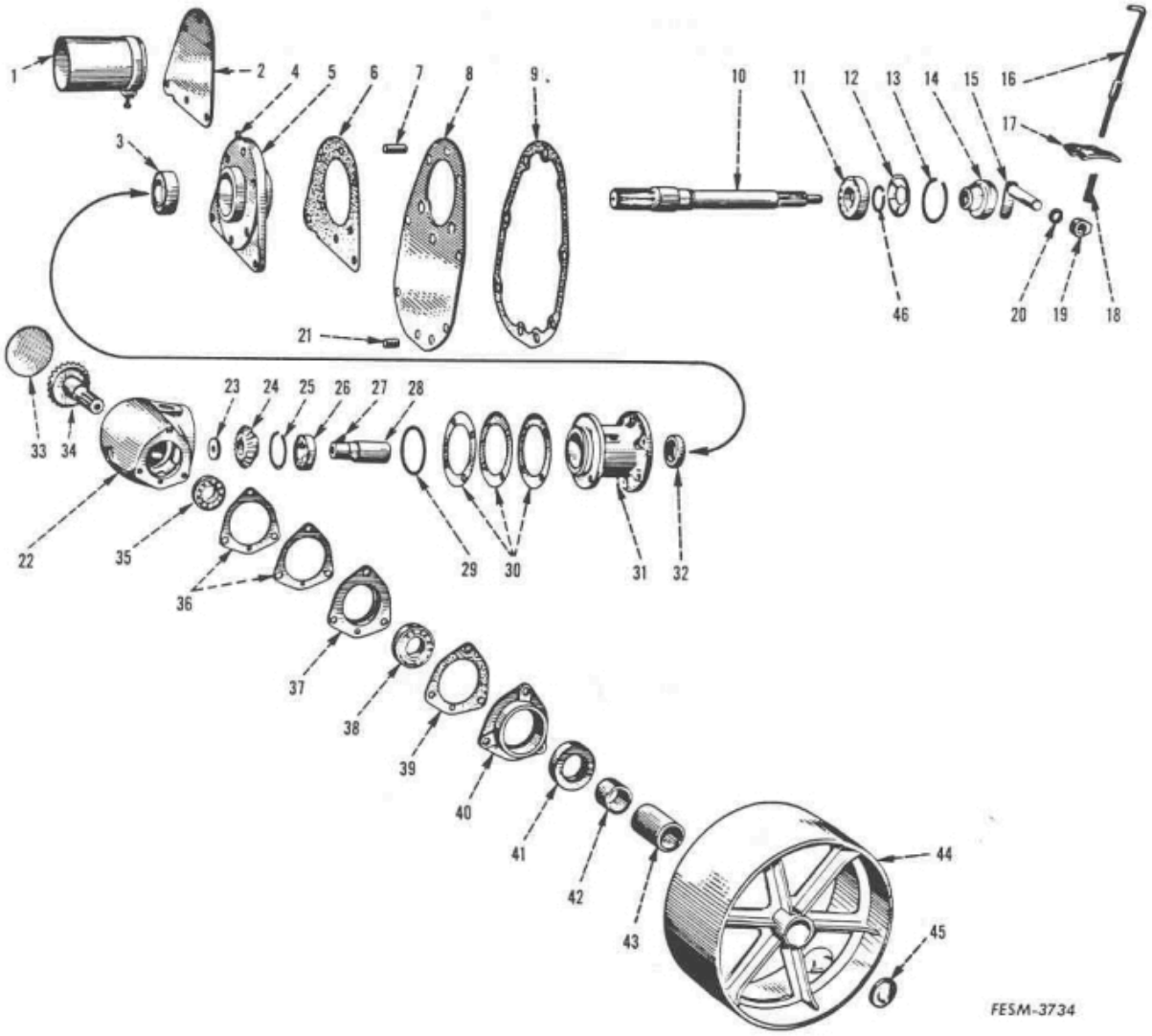
PTO shaft diameters

At front bushing location - inch	.3725 to .3732
At rear bearing location - inch	.9842 to .9846

1. Power take-off shaft guard
2. PTO adapter cover
3. PTO shaft oil seal
4. Lubrication fitting
5. PTO shaft oil seal and bearing retainer assembly
6. Gasket
7. Dowel
8. PTO adapter
9. Adapter gasket
10. PTO shaft
11. PTO shaft bearing
12. Bearing grease shield
13. Snap ring
14. Shifter clutch
15. Shifter lever and shaft
16. Shifter rod
17. Shifter rod guide
18. Shifter rod spring
19. Shifter lever collar
20. Shifter shaft seal
21. Dowel
22. Belt pulley drive housing
23. Drive pinion washer
24. Drive pinion
25. Snap ring
26. Bearing
27. Woodruff key
28. Drive pinion sleeve
29. Drive housing seal
30. Shims
31. Drive housing support
32. Oil seal
33. Expansion plug
34. Belt pulley drive shaft
35. Drive shaft inner bearing
36. Shims
37. Bearing cage
38. Drive shaft outer bearing
39. Oil seal retainer gasket
40. Oil seal retainer
41. Drive shaft oil seal
42. Belt pulley spacer
43. Drive shaft spacer
44. Belt pulley
45. Washer
46. PTO bearing snap ring (if shaft has groove)

BELT PULLEY

Removal and Disassembly



1. Remove the belt pulley assembly from the PTO assembly and drain the lubricant from the drive housing.

2. Remove the cap screws and remove the belt pulley drive housing support (31), bearing (26), drive pinion sleeve (28) and drive pinion (24) from the belt pulley drive housing (22).

NOTE: Retain the shims (30) for use in reassembly.

3. Remove the drive pinion retaining cap screw and remove the pinion (24), snap ring (25), and bearing (26) from the drive pinion sleeve (28).

4. Remove the expansion plug (33) from the housing (22).

5. Remove the belt pulley retaining cap screw, and remove the belt pulley (44) and spacers from the pulley drive shaft (34).

6. Remove the cap screws, and remove the drive shaft oil seal retainer (40), drive shaft bearing cage (37) and shims (36) and outer bearing (38).

NOTE: Retain the shims (36) for use in reassembly.

7. Remove the belt pulley drive shaft (34) and inner bearing (35) out of the drive housing (22).

Inspection and Repair

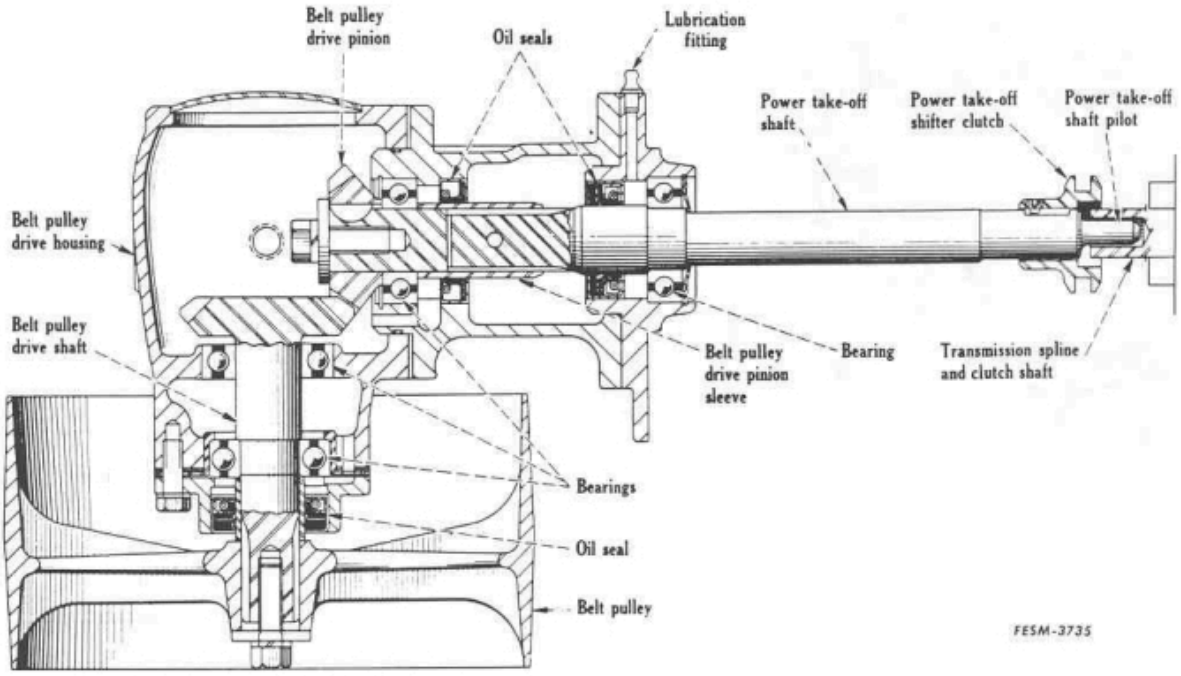
1. Inspect the bearings for wear or damage and replace as necessary.

2. Inspect the gears for wear and damaged teeth. Inspect the shaft for signs of wear or damage.

3. Check the drive housing for cracks and replace if necessary.

4. Be sure to use new gaskets and oil seals in reassembly.

Reassembly and Installation



1. Install the drive shaft and inner bearing in the drive housing.

2. Install the outer bearing, bearing cage and shims in the housing.

3. Install the drive shaft oil seal retainer with a new oil seal and gasket.

4. Tighten the cap screws to 20 ft. lbs. torque.

5. Install the belt pulley and spacers on the drive shaft and tighten the retaining cap screw to 35 ft. lbs. torque.

6. Reassemble the drive pinion sleeve, bearing and drive pinion. Tighten the retaining cap screw to 35 ft. lbs. torque.

7. Install a new oil seal and O-ring in the drive housing support.

8. Install the drive housing support, shims and drive pinion and bearing assembly in the drive housing.

9. Check for specified bevel gear backlash which is .003 to .005 inch. Adjust by adding or removing shims.

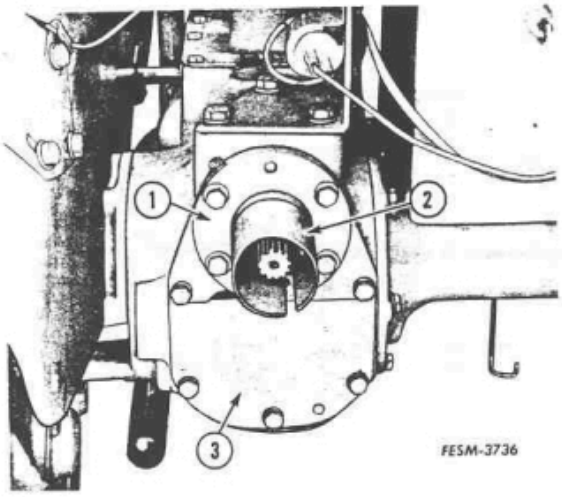
10. Install a new expansion plug in the drive housing.

11. Install the belt pulley assembly on the tractor, and tighten the cap screws to 35 ft. lbs. torque.

12. Fill the drive housing with IH Hy-Tran fluid (refer to Operator's Manual).

POWER TAKE–OFF

Removal



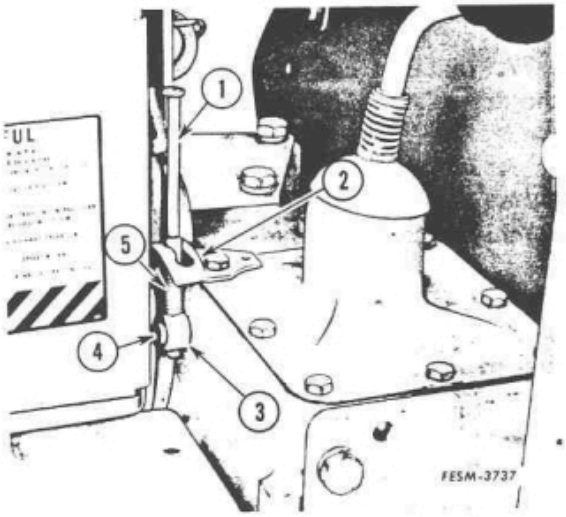
1. Remove the belt pulley assembly if equipped.

2. Remove the PTO shaft guard (2).

3. Remove the cap screws from the PTO shaft oil seal and bearing retainer assembly (1).

4. Remove the PTO assembly from the transmission case.

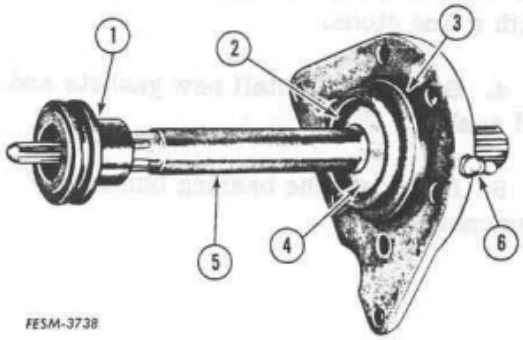
1. PTO shaft oil seal and bearing retainer
2. Shaft guard
3. PTO adapter plate



5. Remove the PTO shifter rod (1) and collar (3) from the shifter lever and shaft (4). Remove the lever and shaft and its seal from the transmission case.

1. PTO shifter rod
2. Shifter rod guide
3. Shifter lever collar
4. Shifter lever and shaft
5. Shifter rod spring

Disassembly



FESM-3738

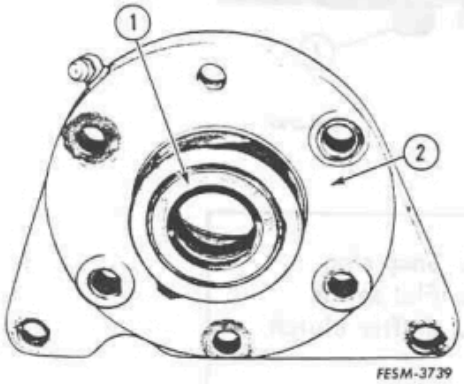
1. Shifter clutch
2. Snap ring
3. Oil seal and bearing retainer assembly
4. Bearing grease shield
5. PTO shaft
6. Grease fitting

1. Remove the set screw in the shifter clutch (1) and remove the clutch.

2. Remove the snap ring (2) and the bearing grease shield (4).

3. Press the shaft and bearing out of the oil seal and bearing retainer assembly (3).

4. Remove the bearing retaining snap ring (if the shaft has one) and press the PTO shaft out of the bearing.



FESM-3739

5. Remove the shaft oil seal (1) from the bearing retainer (2).

1. Oil seal
2. Bearing retainer assembly

Inspection and Repair

1. Wash all parts in cleaning solvent and dry with compressed air. Do not spin the bearing.

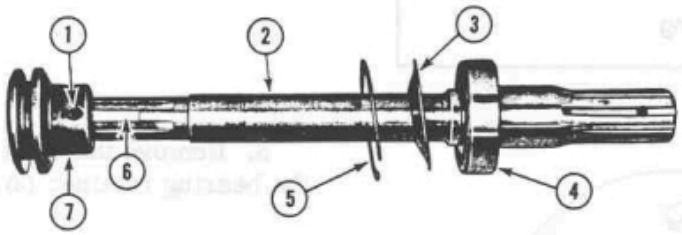
2. Check the bearing for looseness, wear, roughness, pitting and scoring, and replace if necessary.

3. Check the shaft and shaft splines for wear and burrs. Remove any burrs with a fine stone.

4. Be sure to install new gaskets and oil seal.

5. Lubricate the bearing before reassembly.

Reassembly



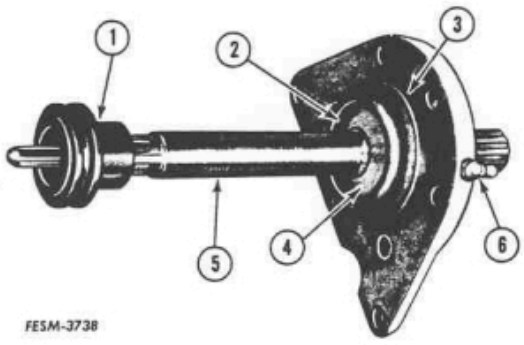
FESM-3740

1. Set screw
2. PTO shaft
3. Grease shield
4. Bearing
5. Snap ring
6. Flat spline
7. Shifter clutch

1. Install a new seal and the shifter lever and shaft in the transmission case if it was removed. Install the shifter rod and collar on the lever and shaft.

2. Install a new oil seal in the bearing retainer.

3. Press the bearing (4) on the PTO shaft (2) and install the bearing retaining ring (if one is used).



FESM-3738

1. Shifter clutch
2. Snap ring
3. Oil seal and bearing retainer assembly
4. Grease shield
5. PTO shaft
6. Grease fitting

4. Install the shaft and bearing in the oil seal and bearing retainer assembly (3).

5. Install the bearing grease shield (4) and the snap ring retainer (2).

6. Install the shifter clutch (1) on the shaft being sure the set screw is aligned with the flat spline on the PTO shaft.

7. Tighten the set screw only enough to prevent the shifter clutch from coming off the shaft.

8. Lubricate the bearing at the grease fitting (6) with recommended lubricant. (Refer to Operator's Manual).

Installation

1. Remove the transmission oil filler plug and use the opening as an inspection hole when engaging the shifter lever with the shifter clutch.

2. Apply a coating of grease to the pilot end of the PTO shaft, and install the PTO assembly through the hole in the adapter plate and engage the shifter lever pin in the groove of the shifter clutch.

3. Move the assembly forward and insert the pilot end of the power take-off shaft into the rear end of the transmission spline and clutch shaft.

4. Install the cap screws in the seal and bearing retainer and tighten to 35 ft. lbs. torque.

Section 7

FINAL DRIVE AND BRAKES

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BRAKES	
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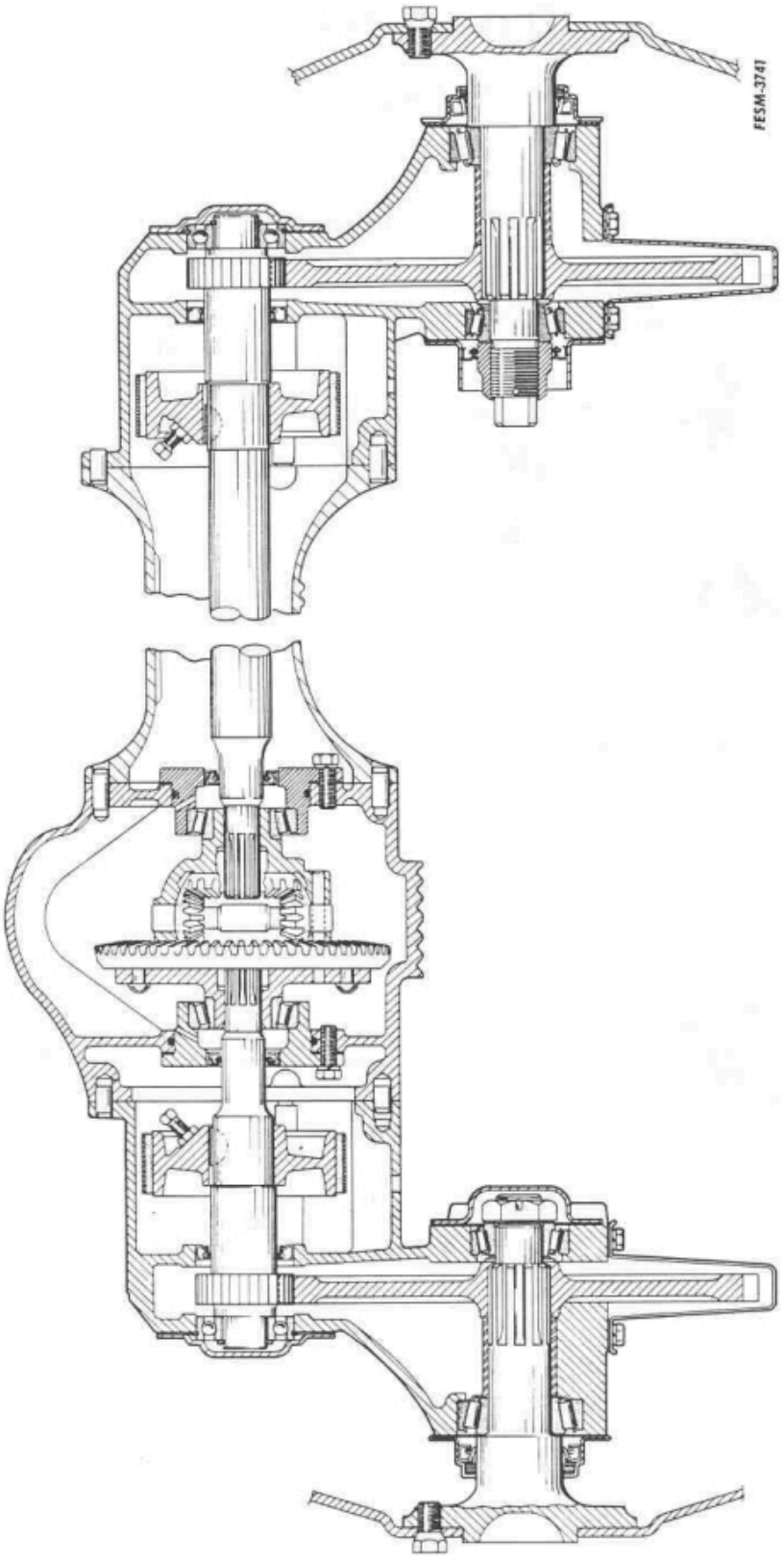
Brake Adjustment	7-10

SPECIFICATIONS

Final Drive	
Type	Spur gears
Location	Rear axle housings
Rear Axles	
Bearings (2 each)	Tapered roller
Axle OD	
For outer bearing - inches	1.6260 to 1.6265
For inner bearing - inches	1.1905 to 1.1910
Bearing pre-load (oil seal not installed)	10 to 20 inch lbs. rolling torque
Oil seal	Lip inward
Differential Shafts	
Bearings (1 each)	Ball
Shaft OD for bearing - inches	1.1810 to 1.1813
Oil seal	Lip outward
Gear backlash - inch	.005 to .010
Brakes	
Type	External contracting drum brakes
Location	Differential shafts
Pedal free travel - inch	7/8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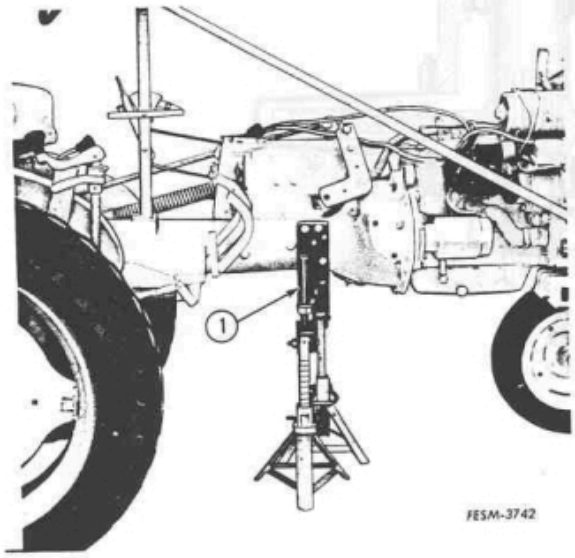
FINAL DRIVE

Removal

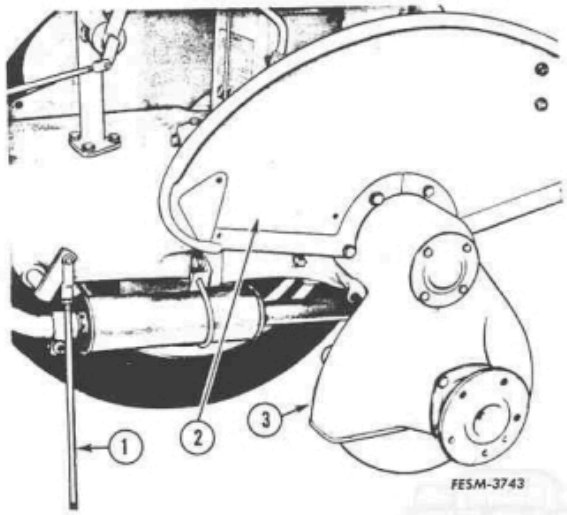


1. Block the front wheels so the tractor cannot move. Drive wooden wedges between the front axle and the tractor on both sides to stabilize the tractor.

2. Raise the rear of the tractor and support it with stands FES 142-1 (1).

3. Remove the rear wheels.

1. FES 142-1

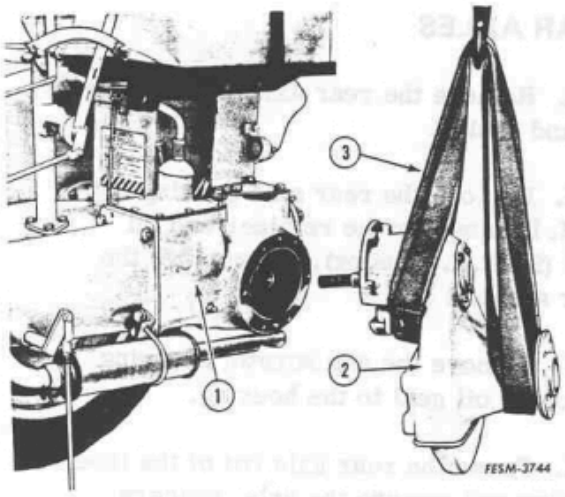


4. Disconnect the brake operating rods (1).

5. Remove the fenders (2).

6. Remove the drawbar or fast hitch assembly from the rear axle housings.

1. Brake operating rod
2. Fender
3. Final drive assembly



7. Remove the cap screws securing the rear axle housings (2) to the transmission case (L.H. housing) or the differential shaft housing (R.H. housing). Support the final drive assemblies and remove them from the tractor.

8. Remove the drain plugs from the housings and drain the lubricant.

1. Transmission case
2. Rear axle housing
3. Nylon sling, FES 138

Disassembly

DIFFERENTIAL SHAFTS

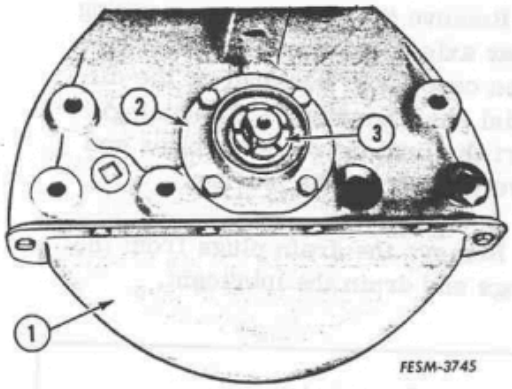
1. Loosen the lock nut and set screw securing the brake drum to the differential shaft. Remove the brake assembly from the shaft.

2. Remove the bearing retainer cap.

3. Remove the differential shaft from the rear axle housing.

4. Remove the retaining ring and remove the ball bearing from the shaft if service is necessary.

5. Remove the oil seal from the housing.



1. Housing pan
2. R.H. retainer and oil seal
3. Rear axle nut

REAR AXLES

1. Remove the rear axle housing pan (1) and gasket.

2. Remove the rear axle bearing cap (L.H. housing) or the retainer and oil seal (2) (R.H. housing), and remove the rear axle nut (3).

3. Remove the cap screws securing the outer oil seal to the housing.

4. Press the rear axle out of the inner bearing and remove the axle, spacers, shims and rear axle drive gear. Be sure to retain the shims for use in reassembly.

5. Remove the outer bearing and oil seal from the axle.

Inspection and Repair

1. Wash all parts in cleaning solvent and dry with compressed air. Do not spin bearings.

2. Check all bearings for looseness, wear, roughness, pitting and scoring, and replace if necessary.

3. Check all gears and shafts for wear and burrs. Remove any burrs with a fine stone.

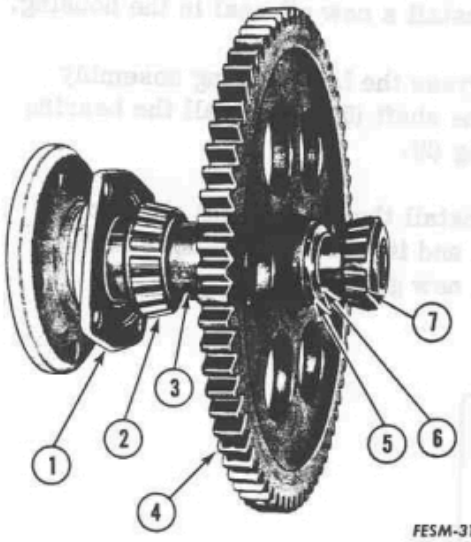
4. Replace all gaskets and oil seals.

5. Check for any damaged or worn snap ring retainers, and replace if necessary.

6. Lubricate bearings and gears before reassembly.

Reassembly

REAR AXLES



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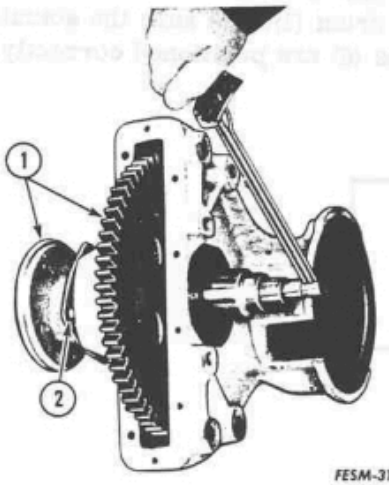
1. Outer oil seal
2. Outer bearing
3. Spacer
4. Rear axle drive gear
5. Spacer
6. Shim
7. Inner bearing



FESM-3194

1. Rear axle assembly
2. Outer oil seal

NOTE: Install the rear axles before installing the differential shafts.

1. Be sure to install new outer oil seals (1) and gaskets.

2. Press the outer bearing (2) on the rear axle. Be sure the bearing bottoms against the shoulder on the shaft.

3. Install the rear axle assembly in the housing. Be sure the spacers (3 and 5) and shims (6) are installed in the proper order.

4. Press the inner bearing (7) on the shaft.

5. Install the rear axle nut and tighten securely.

6. Check for specified bearing preload as follows:

(a) A drag torque of 10 to 20 inch pounds is necessary to rotate the rear axle assembly (1) before the outer oil seal (2) is bolted in place.

(b) To adjust for specified preload, remove the rear axle assembly from the housing and add or remove shims.

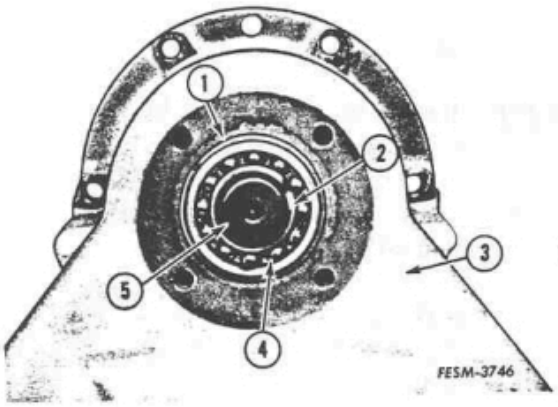
7. Install the cotter pin in the rear axle nut.

8. Bolt the outer oil seal in place.

9. Install the bearing cap (L.H. housing) or the retainer and seal assembly (R.H. housing).

10. Install the axle housing pan and gasket.

DIFFERENTIAL SHAFTS

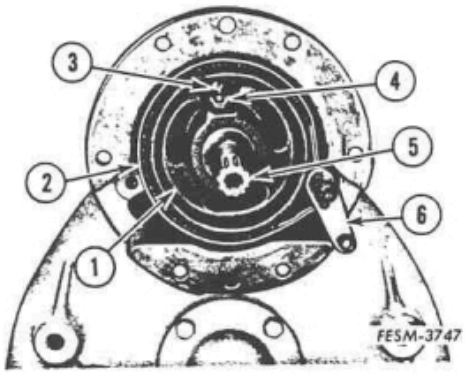


1. Install a new oil seal in the housing.

2. Press the ball bearing assembly (4) on the shaft (5) and install the bearing lock ring (2).

3. Install the differential shaft in the housing and install the bearing retainer cap and new gasket.

1. Snap ring
2. Bearing lock ring
3. Rear axle housing
4. Bearing
5. Differential shaft

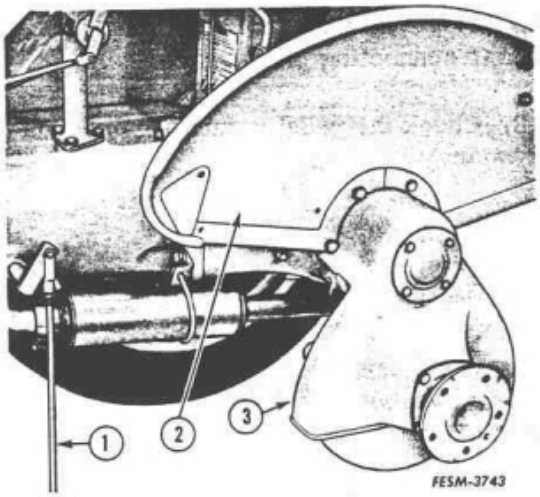


4. Align the brake drum keyway with the key on the differential shaft and install the brake drum (1) on the shaft (5). Tighten the set screw (3) and lock nut (4) securely.

5. Install the brake band (2) on the brake drum (1). Be sure the actuating toggles (6) are positioned correctly.

1. Brake drum
2. Brake band
3. Set screw
4. Lock nut
5. Differential shaft
6. Actuating toggle

Installation



1. Brake operating rod
2. Fender
3. Final drive assembly

1. Install the final drive assemblies on the tractor.

2. Install the fenders (2), and then install the cap screws securing the rear axle housings to the transmission case (L.H. housing) or the differential shaft housing (R.H. housing). Tighten the cap screws to 35 ft. lbs. torque.

3. Connect the brake operating rods (1).

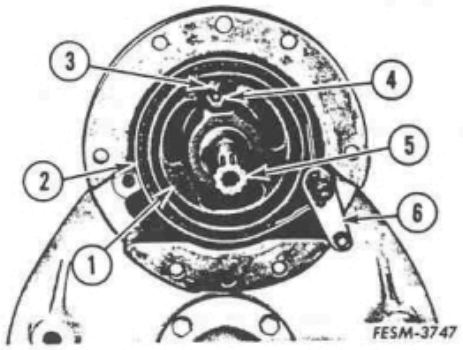
4. Install the rear wheels and tighten the lug bolts securely.

5. Install the drawbar.

6. Fill the housings to the correct level with Hy-Tran fluid.

BRAKES

Removal



1. Brake drum
2. Brake band
3. Set screw
4. Lock nut
5. Differential shaft
6. Actuating toggle

1. Remove the final drive assemblies. Refer to page 7-4.

2. Remove the brake bands (2) from the brake drums (1).

3. Loosen the lock nut (4) and set screw (3) and remove the brake drum (1) from the differential shaft (5).

Inspection and Repair

1. Inspect the brake band and drum for damage and excessive wear. Replace them if there is any doubt of their serviceability.

2. Inspect the control rods for wear at their connecting pivot points.

3. Check the pedal return spring ends for wear.

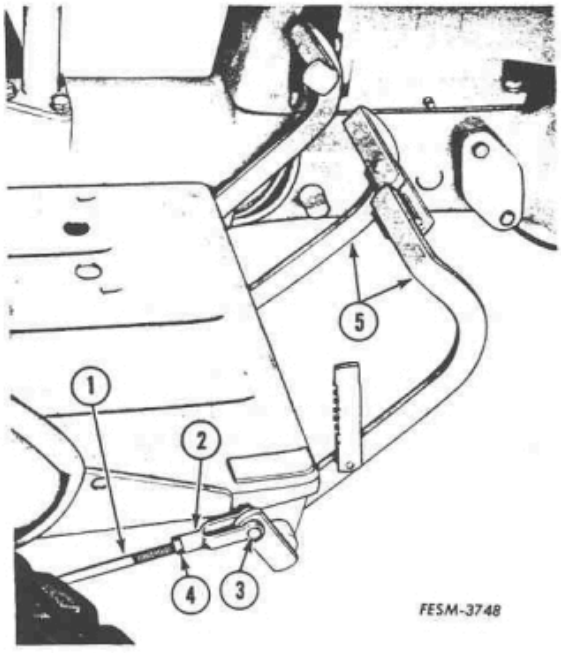
Installation

1. Align the keyway in the brake drum with the key on the differential shaft and install the drum on the shaft. Tighten the set screw and lock nut securely.

2. Install the brake band on the drum. Be sure the brake band pivot pin is positioned in its bore in the final drive housing.

3. Install the final drive assembly on the transmission case. Refer to page 7-9.

Brake Adjustment



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The brakes should not drag before they are applied. The pedals should have a free movement, by hand, of approximately 7/8-inch.

To adjust the brakes, jack up the rear end of the tractor. Remove the pin (3) and loosen the lock nut (4). Turn the adjusting yoke (2) until each wheel drags slightly when turned. Then loosen the adjusting yoke until no drag occurs, and the pin can be installed.

Replace the pin (3) and tighten the lock nut (4) after the adjustment has been completed.

1. Brake operating rod
2. Brake adjusting yoke
3. Pin
4. Lock nut
5. Brake pedals

It is very important to have the brakes equalized. To have equalized brakes, both pedals must have the same amount of free movement.

To check the equalization of the brakes, jack up both rear wheels so they will turn freely, block the tractor securely and latch the brake pedals together; then start the engine. Shift the gears to either third or fourth speed and engage the clutch; while the wheels are turning, apply the brakes.

Application of the brakes should slow down both wheels at the same time and also reduces the speed of the engine.

If one wheel stops and the other wheel continues to revolve when the brakes are applied, loosen the adjustment on the wheel that stops just enough so both wheels stop simultaneously when the brakes are applied.

Section 8

HYDRAULIC SYSTEM
Touch-Control

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GSS-1411 (Rev. No. 1)

Printed in United States of America

SPECIFICATIONS

	* Blocks 351 981 R1, 354 383 R1 thru R4	* Block 360 719 R1
Type (Touch-Control)	Double acting cylinder and single rockshaft	
Operating pressure	1100 to 1500 psi	1100 to 1500 psi
Control	Hand lever	Hand lever
Reservoir capacity	4-1/4 pints IH Hy-Tran	4-1/4 pints IH Hy-Tran
Pump	External mounted	
Type	Single stage spur gear	
Drive	Engine timing gears	
Capacity (at rated engine speed)	2.8 gpm	2.8 gpm
Cylinder block		
Piston bore - inches	2.0005 to 2.0040	2.0005 to 2.0040
Piston		
Head diameter - inches	1.997 to 1.999	1.997 to 1.999
Sleeve diameter - inches	1.358 to 1.359	1.358 to 1.359
Safety valve spring		
Free length - inches	—	1-13/16
Test length - inches	—	1-3/8
Test load - pounds	—	74.2
Check valve spring (2)		
Free length - inch	53/64	53/64
Test length - inch	11/16	11/16
Test load - pounds	2-1/2 ± 20%	2-1/2 ± 20%

* The cylinder block number is cast on the side of the block.

	*Blocks 351 981 R1, 354 383 R1 thru R4	*Block 360 719 R1
Regulator valve check valve spring		
Free length - inches	—	1-15/32
Test length - inches	—	1-1/8
Test load - pounds	—	6.22 ± 5%
Regulator valve ball rider spring		
Free length - inches	1-7/16	—
Test length - inches	1-1/32	—
Test load - pounds	16.7 ± 5%	—
Safety valve piston diameter - inch	.2495 to .2500	.3120 to .3125
Orifice plug opening - inch	.024	.024
Connecting rod bushing (after installation) - inch	.6868 to .6878	.6868 to .6878

*The cylinder block number is cast on the side of the block.

GENERAL

Cleaning

Strict cleanliness is necessary when servicing the hydraulic Touch-Control system. Use only clean solvent. Keep the bench clean. Keep all tools clean.

Before proceeding with removal of any parts from the hydraulic cylinder block or pump unit, remove all oil and dirt from the outside surfaces. Then use fresh solvent to clean the dismantled parts.

Clean the passages in the block with a round bristle brush, petroleum solvent, and air pressure. Be very careful when handling the hydraulic system parts. Careless handling will damage the finished surfaces, producing nicks and abrasions which will affect the sealing ability and the life of the seal rings and gaskets.

After parts are cleaned, dry them with air pressure. Do not use old rags or cotton waste to clean internal surfaces or internal parts of the system. Small particles of lint from such material may adhere to the metal and prevent the various valves from seating.

When installing O-rings, use a good grade of light cup grease as a lubricant. Light cup grease is helpful, too, in retaining valves and springs during assembly. Cup grease also provides needed initial lubrication — before the IH Hy-Tran fluid is circulating normally.

Handling of O-Rings

When handling O-rings and the metal parts they fit, remember that dirt, grit, rough surfaces, and nicks all shorten the life of the rings. Handle parts carefully and keep them clean. Use crocus cloth to remove burrs and nicks in finished metal surfaces contacted by the O-rings and in the O-ring grooves.

If necessary to clean new O-rings, use IH Hy-Tran fluid. Any other cleaning agent may be harmful.

After metallic lift parts or the block and cylinder head have been cleaned in a solvent, they must be wiped dry or blown dry.

O-rings must be rolled, rather than pushed, to their grooves. Use a good grade of light cup grease for lubricant. Check to be sure that the rings are straight and not twisted in their grooves.

Use a rotary motion when inserting O-ring-equipped parts in their bores. A straight push will damage the O-ring.

PRINCIPLES OF OPERATION

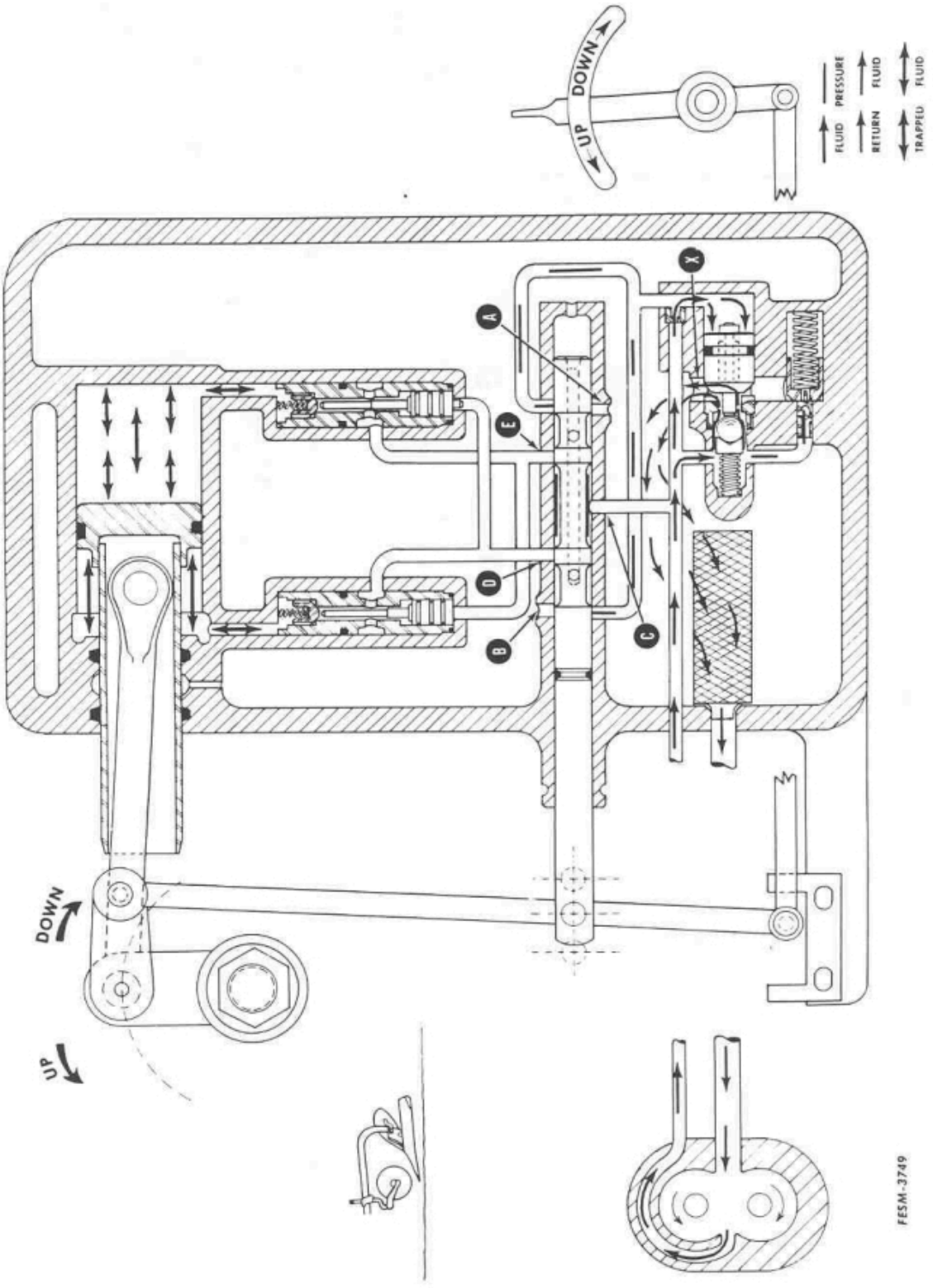
The following explanation of the operation of the Touch Control is based on the late model Touch Control unit. However, the early Touch Control is similar and operates basically the same way.

NOTE: Touch control units with block numbers 351 981 R1 and 354 383 R1 thru R4 are the early design models (see illustrations on pages 8-5, 8-10 and 8-11) and units with block number 360 719 R1 are the late design models (see illustrations on pages 8-6, 8-9 and 8-13).

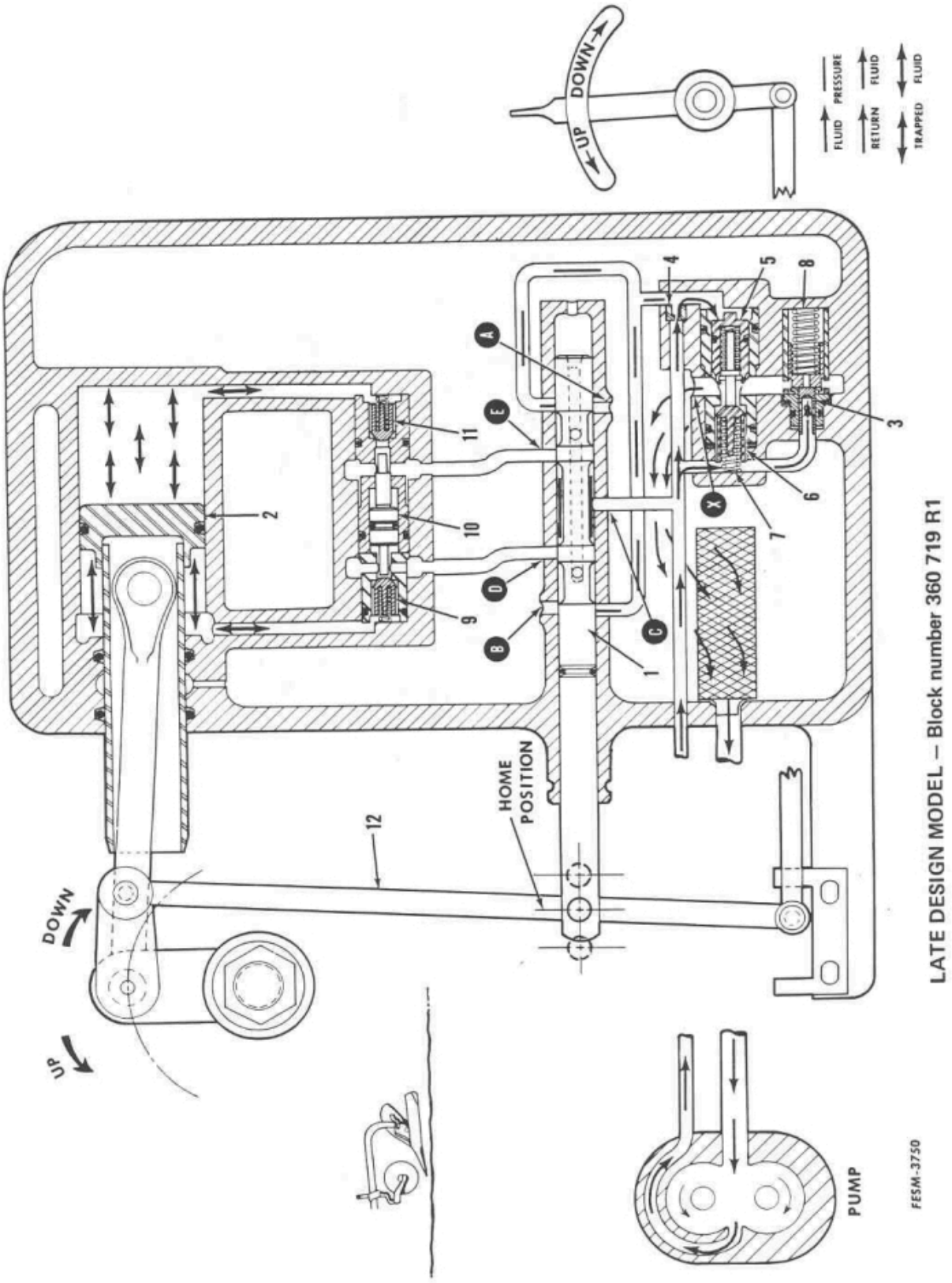
When the pump is in operation with the controls and rockshaft at rest, oil is being circulated under a low pressure from the pump through the pressure regulating valve and back to the pump. (Refer to page 8-7.)

When the operators hand lever is moved to raise or to lower the implement, the pressure regulating valve closes placing the system on high pressure and force is applied to the piston causing the movement of the rockshaft. (Refer to pages 8-8 and 8-12).

In these schematic drawings the various valves and oil lines are not laid out in their true positions within the block, but are arranged in the most simple manner to best illustrate the flow of oil through the system during the different phases of its operation. A better understanding of this hydraulic system may be had by a careful study of these three operational phases illustrated in the drawings and their text.



EARLY DESIGN MODEL — Block numbers 351 981 R1 and 354 383 R1



LATE DESIGN MODEL – Block number 360 719 R1

Hand Control and Rockshaft at Rest, Oil Circulating at Low Pressure

In this schematic drawing, the spool type control valve (1) is in its "home" or neutral position, the valve ports "D" and "E" being covered by the valve. This position prevents movement of oil to or from either side of the rockshaft piston (2).

The output from the hydraulic pump is creating pressure against the closed ports "D" and "E" and the closed high pressure safety valve (3), and passes through the orifice plug (4) to actuate the pressure regulator piston (5). The area of this piston being larger than the check valve (6), results in the piston forcing the check valve (6) off its seat against the oil and spring (7) pressure. This pressure regulating system balances to maintain a pressure of approximately 30 pounds per square inch in the system. Oil thus released by the valve passes out port "X" into the reservoir and back to the pump through the strainer screen.

A small movement of the control valve (1) in either direction from its "home" position by use of the hand lever, would open one of the lines opposite port "A" or "B" allowing more oil to escape than could be supplied through the small orifice plug (4), thus reducing the pressure on the piston (5) allowing the spring (7) to return the check valve (6) to its seat. Seating of the pressure regulator check valve (6) allows the system to build up pressure to the load requirement, or the opening point of the high pressure safety valve (3) which is approximately 1100 to 1500 psi.

The high pressure safety valve piston (3) has three small holes in it near the closed end. As high pressure develops from the operating loads or interference with the rockshaft movement, the piston is forced back against the pressure of the spring (8), uncovering one, two or all of the valve wall holes. Oil thus released by the valve passes out through port "X" into the reservoir and back to the pump through the strainer screen.

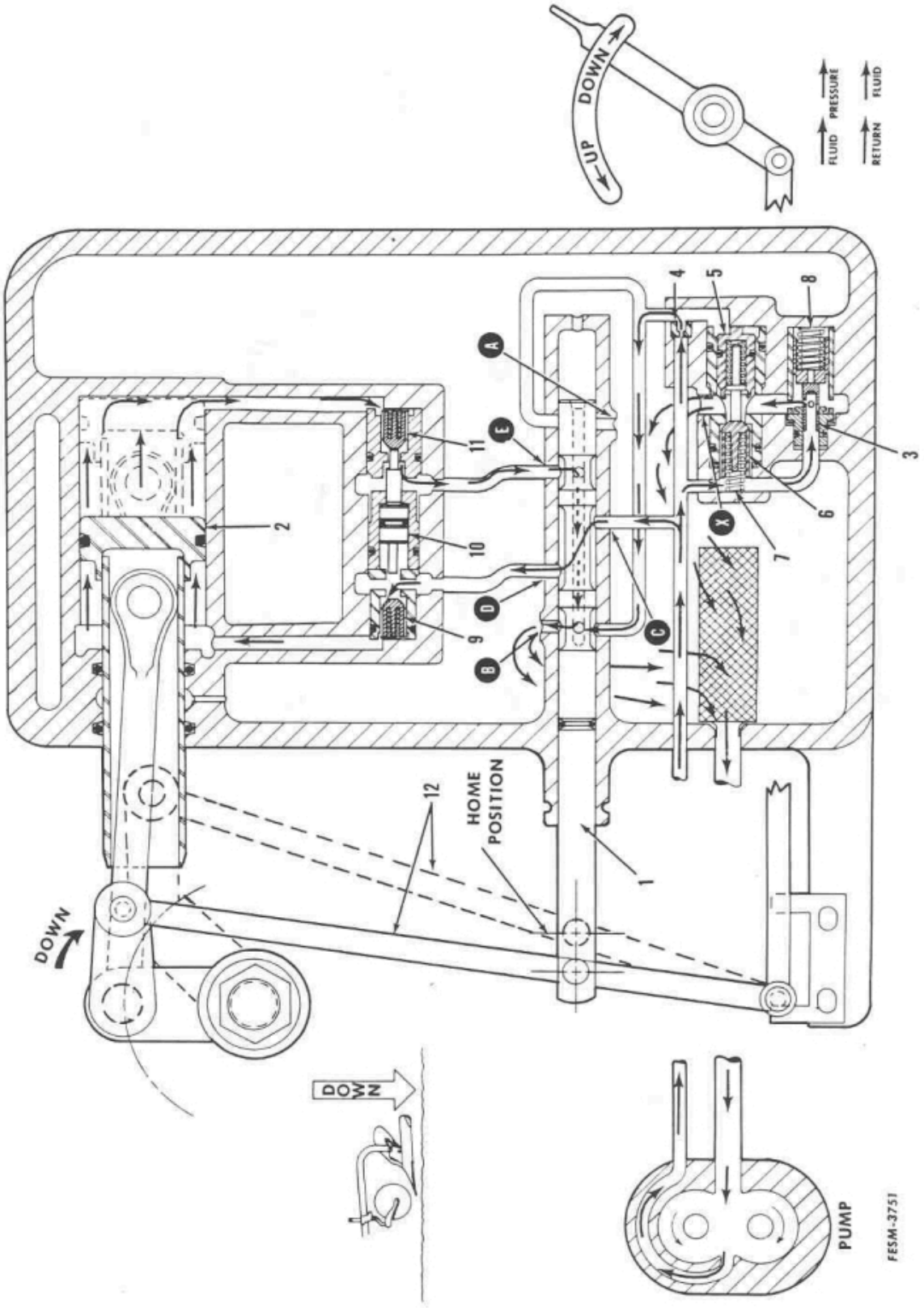
Hand Lever Moved to Lower Implement, Showing Path of Oil to and from Rockshaft Piston

Here the spool type control valve (1) has been pulled out from its "home" position by use of the hand lever, this action released the pressure on the regulator valve piston (5) through the open port "B". This allows the spring (7) to return the check valve (6) to its seat which places the system on high pressure as described previously.

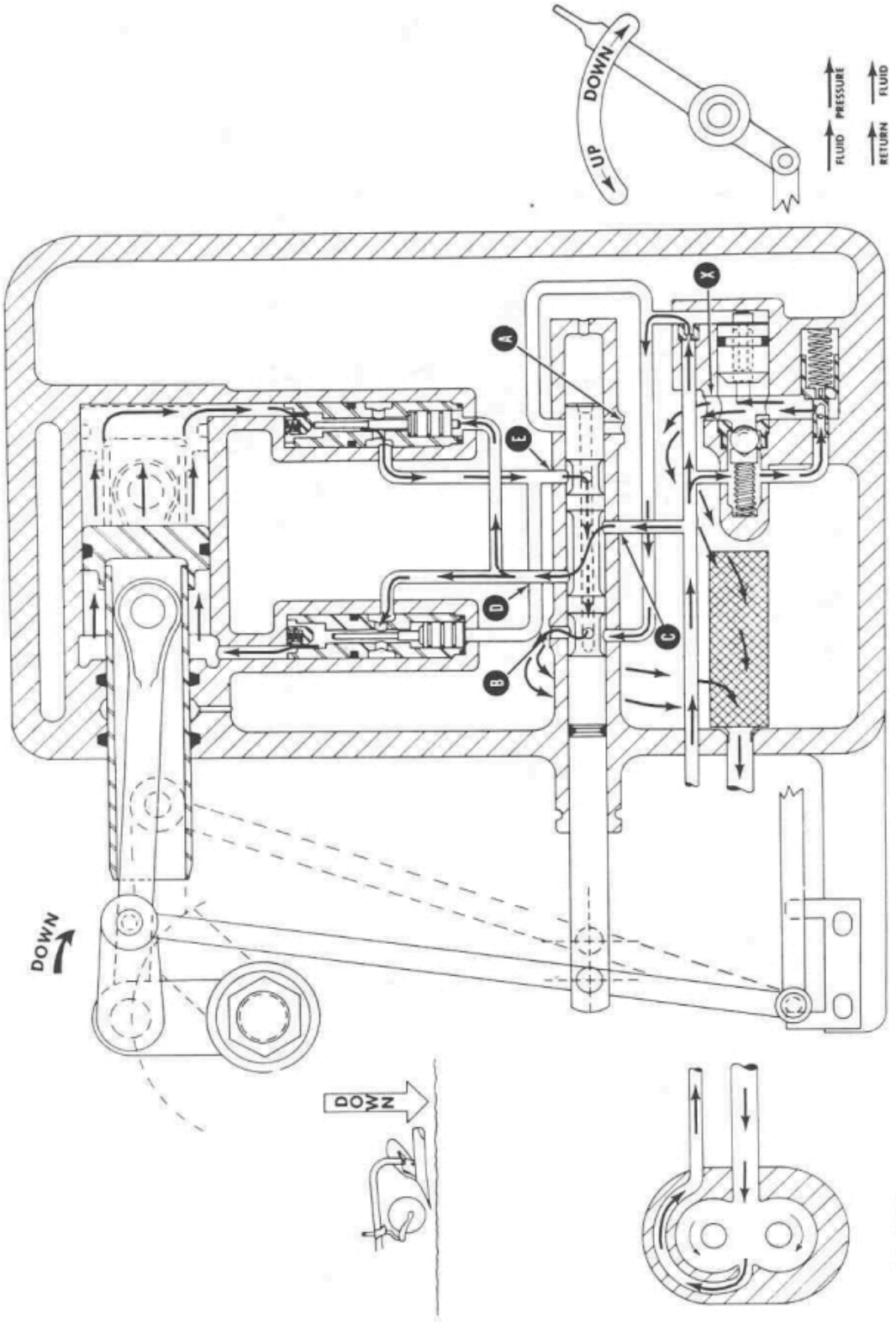
Oil from the pump flows from port "C" around the control valve, out port "D" to the front of the check actuator valve (10) and through the front check valve (9) to the front side of the rockshaft piston (2).

Oil pressure on the check actuator valve (10) causes the actuator to force the rear check valve (11) off its seat allowing the trapped oil at the rear of the rockshaft piston (2) to escape through the port "E", through the drilling in the control valve (1), out port "B" to the reservoir and back to the pump.

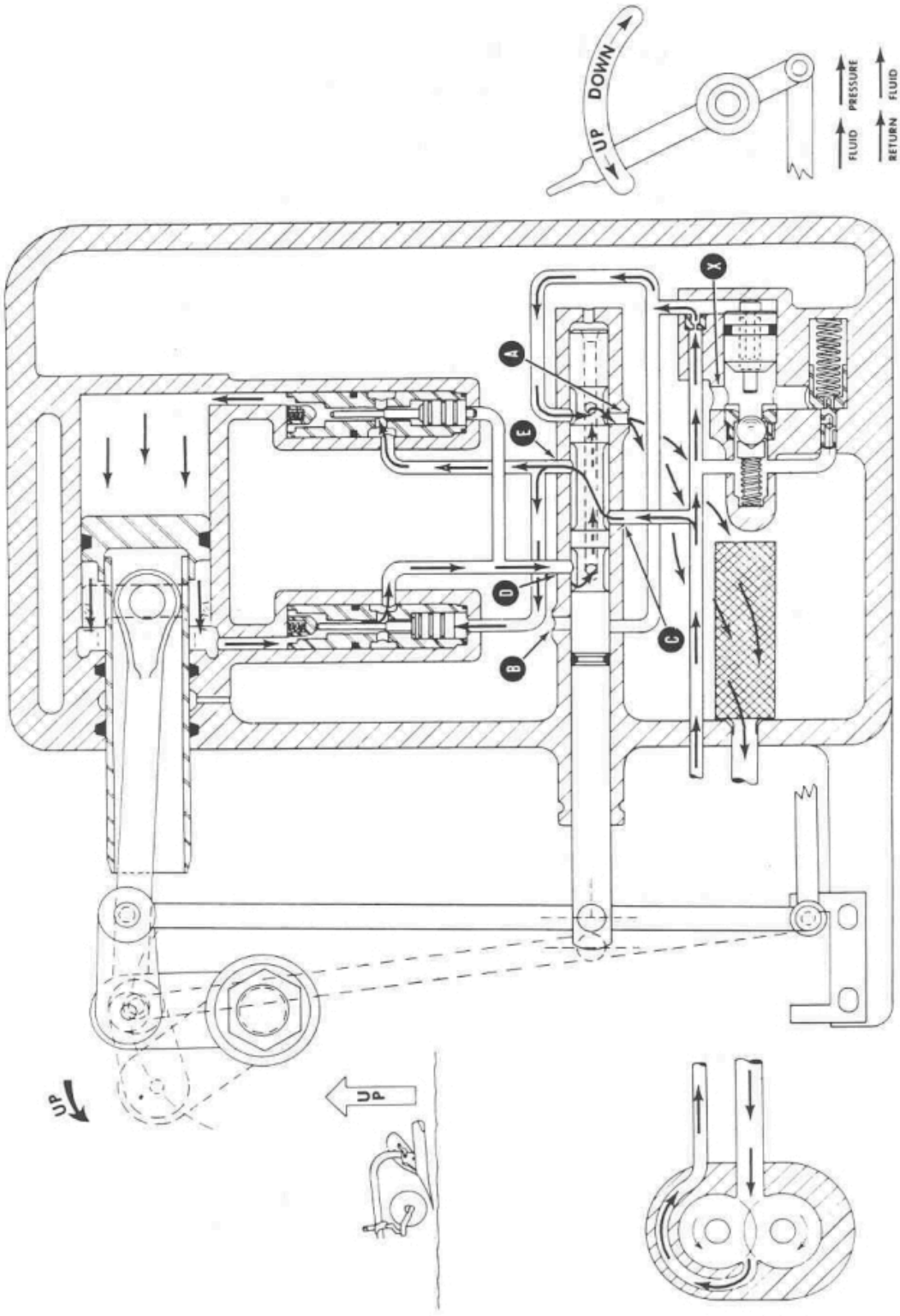
The stem of the check actuator valve (10) is made to form a restriction in the valve bushing port when the piston is forced back by oil pressure, this restriction slows down the movement of the trapped oil from the rear side of the rockshaft piston (2) on its lowering cycle. This tends to prevent the implement weight from being dropped suddenly as the operator moves the hand lever, thus maintaining the same speed in lowering the implement as developed in the raising cycle. Because the pump is delivering oil to the small front area of the rockshaft piston and because the piston speed is restricted, part of the oil is being released through the high pressure safety valve (3) during the lowering cycle, through port "X". The rockshaft, its piston and the operating lever (12) move toward the rear until the control valve operating lever (12) is moved to the position of the dotted lines. This places the spool type control valve (1) in the "home" position. Control valve ports being closed, pressure again moves the regulating valve piston (5) to balance off the system to low pressure range, approximately 30 psi. There being no pressure on either the front or rear of the check valve actuator (10), the check valves (9 and 11) are closed trapping fluid on both sides of the rockshaft piston (2), thus holding the rockshaft at whatever position it was in when the control valve (1) reached "home" position.



LATE DESIGN MODEL – Block number 360 719 R1



EARLY DESIGN MODEL – Block numbers 351 981 R1 and 354 383 R1



EARLY DESIGN MODEL – Block numbers 351 981 R1 and 354 383 R1

Hand Lever Moved to Raise Implement, Showing Path of Oil to and from Rockshaft Piston

In this drawing the hand lever has been moved to raise the implement. This action has moved the spool type control valve (1) in from its "home" position, the pressure on the regulator valve piston (5) has been released through the open port "A", the regulator check valve (6) has been seated by the spring (7) and the system is again under high pressure.

Oil from the pump flows from port "C" around the control valve, out through port "E" to the rear of the check valve actuator (10) and through the rear check valve (11) to the rear side of the rockshaft piston (2).

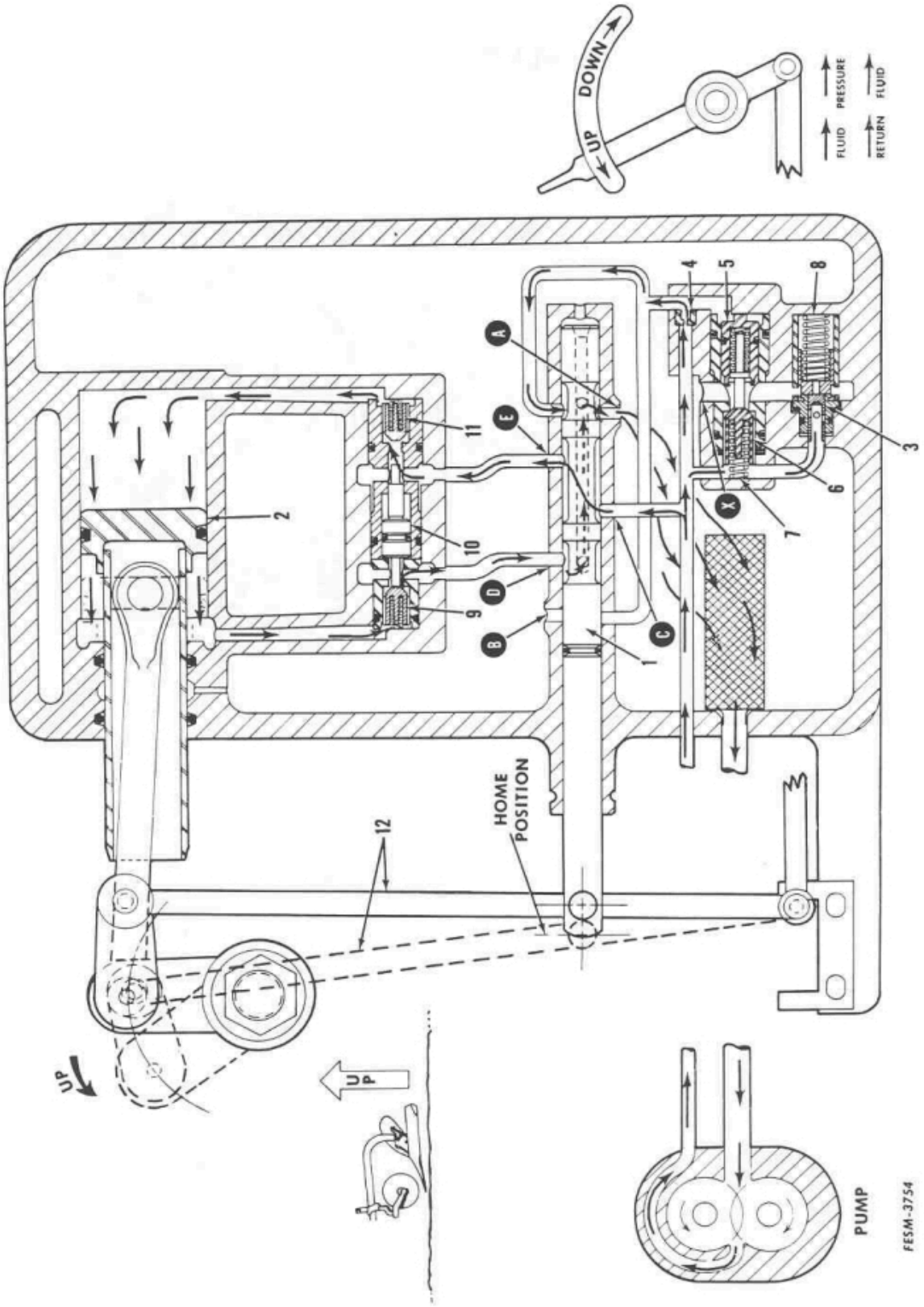
Oil pressure on the rear of the actuator valve (10) forces the front check valve (9) off its seat allowing trapped oil at the front of the rockshaft piston to flow through the port "D", through the drilling in the control valve (1), out port "A" to the reservoir and back to the pump.

The rockshaft, its piston and valve operating lever (12) are forced toward the front until the valve operating lever is in the position as shown by the dotted lines. This completes the raising cycle and again places the spool type control valve (1) in its "home" position which returns the system to low pressure operation. Fluid is trapped on both sides of the rockshaft piston holding the rockshaft firmly in the position it had reached when the control valve (1) reached "home" position.

It will be noticed that a small movement of the hand lever moves the spool type control valve a small amount. This results in a similar small movement of the rockshaft required to return the spool type control valve to its "home" position, through the walking beam type of operating lever (12). Thus the rockshaft responds to any movement of the hand lever, in a similar amount and in a similar direction, up or down; power being required only during the time a change is taking place. Any position of the hand lever is a neutral position after the required movement of the rockshaft is completed.

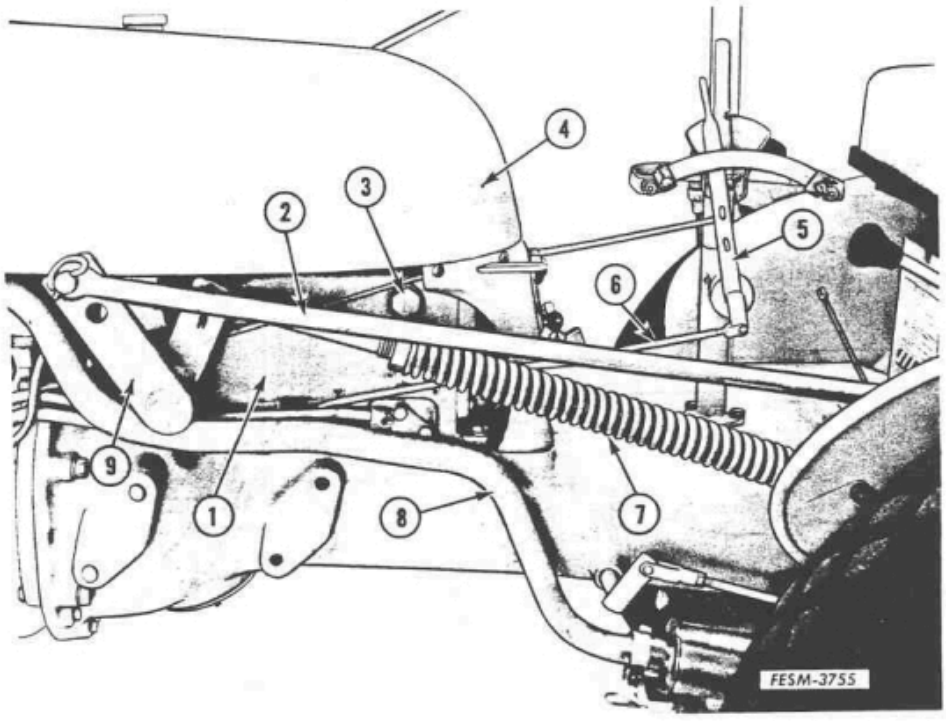
It will also be noticed that any movement of the rockshaft piston depends upon the pressure for the opening of the check valves (9 and 11). Thus with the tractor engine stopped the Touch Control hand lever may be moved to any position without effect on the rockshaft. However, upon restarting the engine, the rockshaft piston will immediately move, correcting any difference between its position and the position of the hand lever.

Pressure gauge FES 1-2 having a pressure range from 0 to 3000 psi may be installed in the place of the 1/4 inch pipe plug located in the pump output side of the hydraulic manifold rear flange. This gauge is designed for test use on hydraulic systems where quick variations of pressure impose a severe shock load on a gauge. Pressure will be indicated only while a change in rockshaft position is taking place. Pressure during this short interval will vary with the load up to 1500 psi at which pressure the safety valve opens in the system.



LATE DESIGN MODEL – Block number 360 719 R1

REMOVAL



1. Cylinder block assembly
2. Lift link
3. Filler plug
4. Hood and fuel tank
5. Hand control lever
6. Control rod
7. Helper spring and rod
8. Exhaust pipe
9. Rockshaft

1. Disconnect the wires to the headlights and remove the headlights.

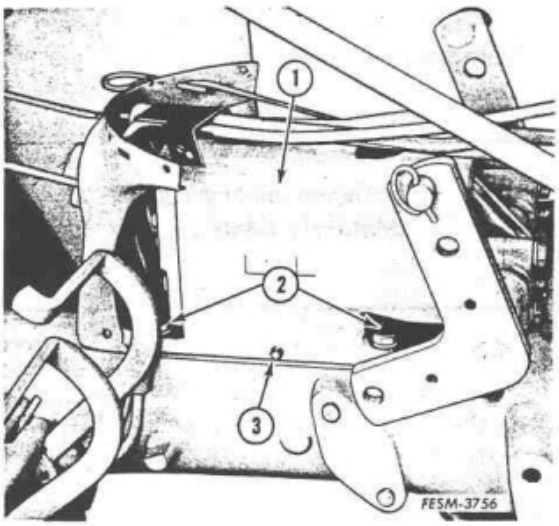
2. Disconnect the fuel line from the fuel strainer, and remove the hood and fuel tank (4).

3. Remove the exhaust pipe (8).

4. Remove the lift link (2) and the helper spring rod and spring (7) from the rockshaft (9).

5. Disconnect the control rod (6) from the hand control lever (5).

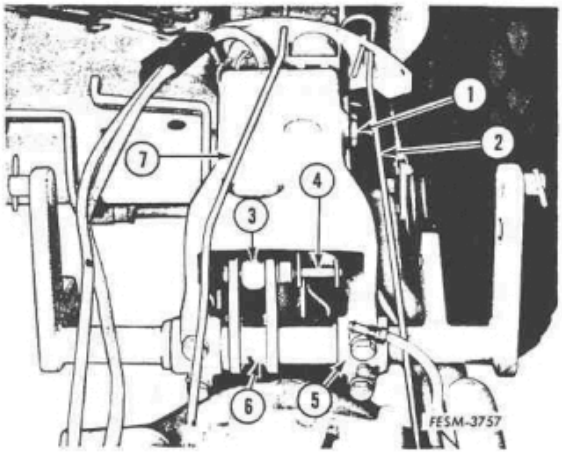
6. Clean the area around the Touch-Control pump and the cylinder block assembly (1).



7. Remove the filler plug and the drain plug (3), and drain the Hy-Tran fluid from the cylinder block (1).

8. Disconnect and remove the manifold tubes from the Touch-Control pump and the cylinder block.

1. Cylinder block
2. Cap screws (4)
3. Drain plug



9. Remove the governor control rod (7).

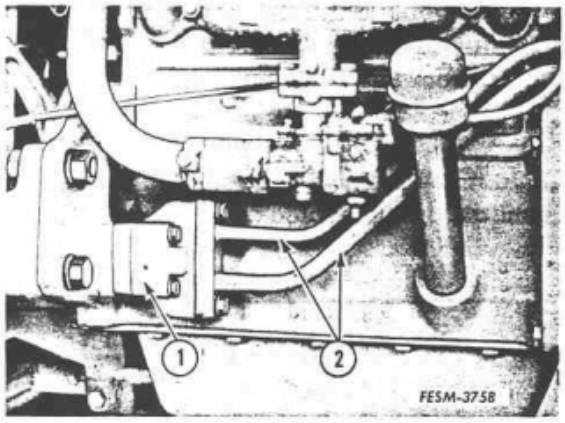
10. Remove the choke control rod (2).

11. Remove the connecting rod pin (4) from the connecting rod (3) and the rockshaft (6).

12. Remove the rockshaft bearings (5) and the rockshaft (6) from the cylinder block.

13. Remove the cap screws, and lift the cylinder block assembly off the tractor.

1. Filler plug
2. Choke control rod
3. Connecting rod
4. Connecting rod pin
5. Rockshaft bearing
6. Rockshaft
7. Governor control rod



14. Remove the Touch-Control pump (1) from the engine.

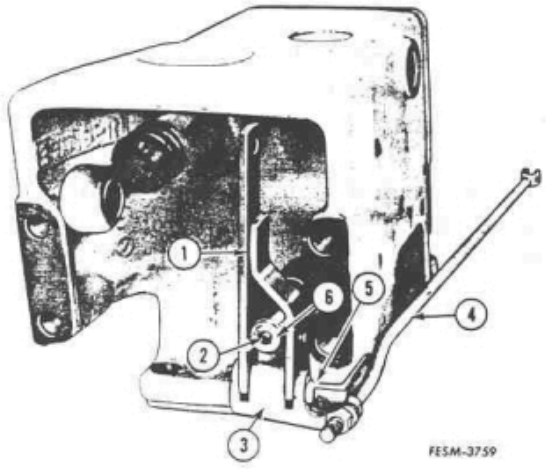
1. Touch-control pump
2. Manifold tubes

DISASSEMBLY

Touch - Control Pump

The Touch-Control pump has a seal ring and gasket package available for service. If the pump requires more than this package, it will be necessary to replace the pump with a new pump assembly.

Cylinder Block

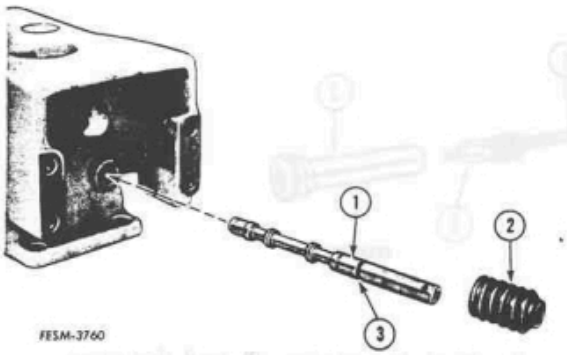


NOTE: Disassembly procedure covers Touch-Control systems with block number 360 719 R1, however, blocks 351 981 R1 or 354 383 R1 thru R4 are similar. The block number is cast on the side of the block.

1. Remove the control rod (4), operating lever stop (5) and the adjusting yoke (3).

2. Loosen the set screw (2) in the control valve (6) and remove the pin and the control valve operating lever (1).

1. Control valve operating lever
2. Set screw
3. Adjustable yoke
4. Control rod
5. Operating lever stop
6. Control valve



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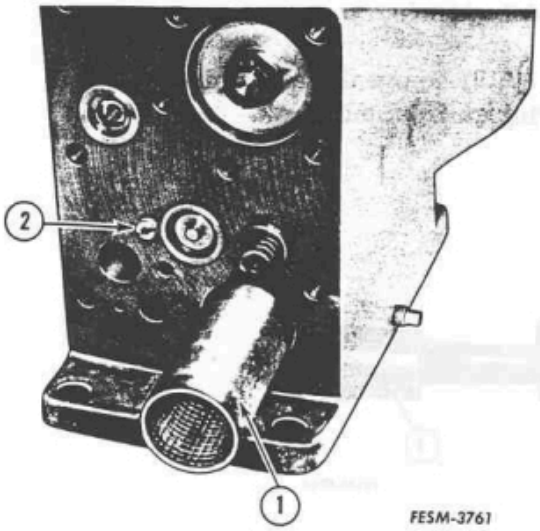
3. Remove the cylinder block cover and gasket from the bottom of the block.

4. Remove the control valve (1) and boot (2) from the block.

1. Control valve
2. Boot
3. O-ring



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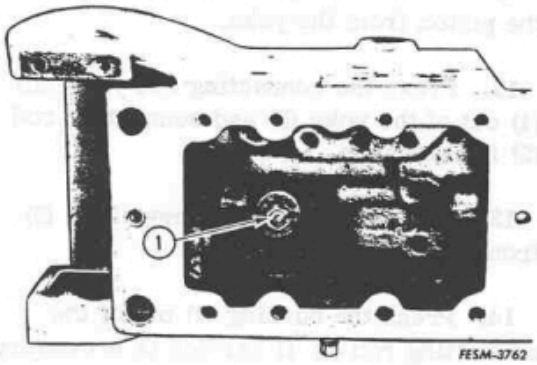
5. Remove the cylinder head and gasket.

6. Remove the cylinder block oil strainer (1).

7. Remove the orifice plug (2) with screen from the tapped hole in the cylinder block.

1. Oil strainer
2. Orifice plug



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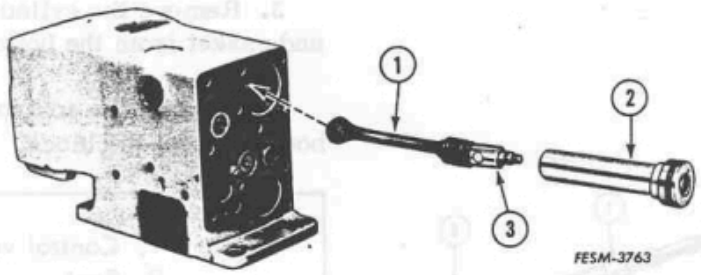
8. Remove the relief valve (1) and screen from the block.

1. Relief valve



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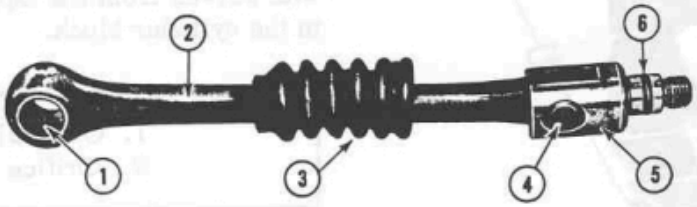
1. Connecting rod
2. Piston
3. Connecting rod yoke

9. Push the piston (2) and the connecting rod assembly (1) out the head end of the block.

10. Remove the piston sleeve seal rings from the block.



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1. Connecting rod bushing
2. Connecting rod
3. Piston sleeve boot
4. Yoke pin
5. Connecting rod yoke
6. Seal ring

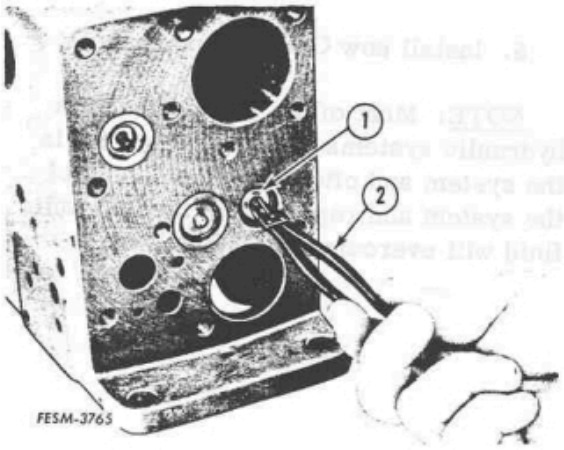
11. Remove the yoke nut and remove the piston from the yoke.

12. Press the connecting rod yoke pin (4) out of the yoke (5) and connecting rod (2) if necessary.

13. Remove the piston sleeve boot (3) from the connecting rod (2).

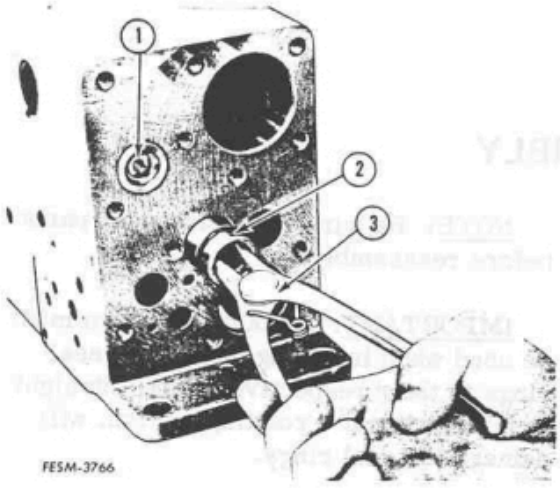
14. Press the bushing (1) out of the connecting rod (2) if service is necessary.

IMPORTANT: When removing the valve assemblies from the cylinder block, rotate and pull outward to overcome the O-ring drag. This eases removal and helps prevent damage to the valve assemblies.



15. Remove the safety valve assembly from the cylinder block using expanding snap ring pliers (2) to remove the inner bushing (1).

1. Safety valve inner bushing
2. Expanding snap ring pliers



16. Remove the pressure regulator valve assembly (2) and the check valve assembly (1) in the same manner as above. Use long needle nose pliers or expanding snap ring pliers as necessary being sure to rotate as you pull outward.

1. Check valve assembly
2. Pressure regulator valve bushing
3. Snap ring pliers

INSPECTION AND REPAIR

1. Wash all parts in clean solvent and dry with compressed air.

2. Inspect all springs for free length and test load. Refer to "Specifications".

3. Inspect the valve assemblies for nicks, wear, galling and scoring. Replace as necessary.

4. Inspect the orifice plug and screen for evidence of dirt, and blow out with air blast.

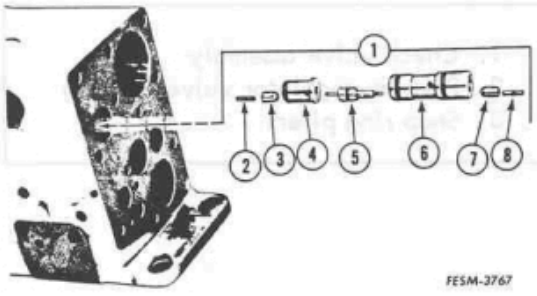
5. Install new O-rings and gaskets.

NOTE: Most of the difficulties with hydraulic systems are caused by dirt in the system and often a good cleaning of the system and replacing of the hydraulic fluid will overcome the difficulties.

REASSEMBLY

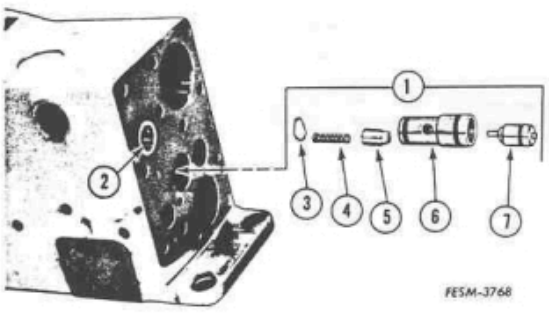
NOTE: Be sure to lubricate all parts before reassembly.

IMPORTANT: A rotating motion must be used when inserting parts with seal rings in their respective bores. Straight pushing, without a rotating motion, will damage the seal rings.



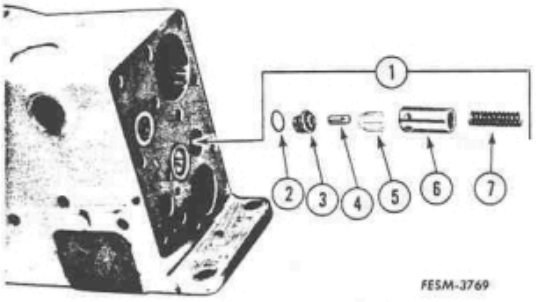
1. Install the check valve assembly (1) in the cylinder block using new O-rings.

1. Check valve assembly
2. Check valve spring
3. Check valve
4. Check valve inner bushing
5. Check valve actuator
6. Check valve outer bushing
7. Check valve
8. Check valve spring



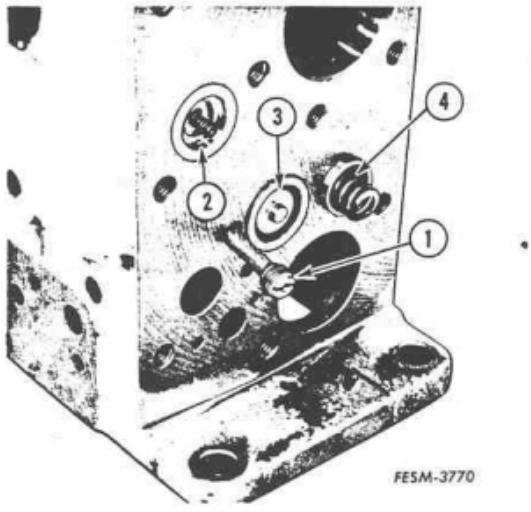
2. Using new O-rings, install the pressure regulator valve assembly (1) in the block.

1. Pressure regulator valve assembly
2. Check valve
3. Tension spring
4. Check valve spring
5. Check valve
6. Pressure regulator valve bushing
7. Pressure regulator valve piston



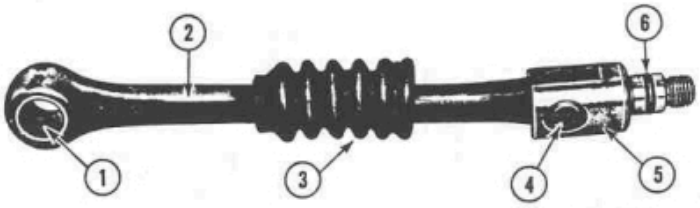
3. Install the safety valve assembly (1) with a new O-ring.

1. Safety valve assembly
2. Tension spring
3. Inner bushing
4. Safety valve piston
5. Safety valve sleeve
6. Outer bushing
7. Safety valve spring



4. Install the orifice plug (1) with screen.

1. Orifice plug
2. Check valve assembly
3. Pressure regulator valve assembly
4. Safety valve assembly



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1. Connecting rod bushing
2. Connecting rod
3. Piston sleeve boot
4. Yoke pin
5. Connecting rod yoke
6. Seal ring

5. Install a new bushing (1) in the connecting rod (2) if it was removed.

6. Install the piston sleeve boot (3) on the connecting rod (2).

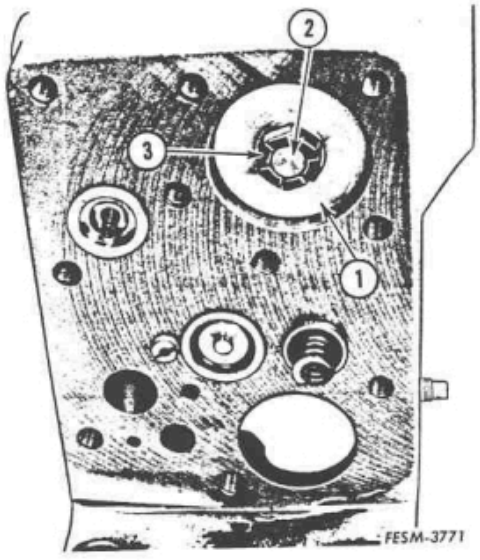
7. Install the connecting rod yoke (5) on the connecting rod (2) and press the connecting rod yoke pin (4) into place. Install a new yoke seal ring.

8. Install new seal rings on the yoke and the piston. Install the yoke in the piston and tighten the nut to 75 ft. lbs. torque.

9. Install new piston sleeve seal rings in the cylinder block.

10. Install the piston (1) and connecting rod assembly in the block.

11. Install the relief valve and screen in the block. Do not overtighten as this could cause distortion and leakage.



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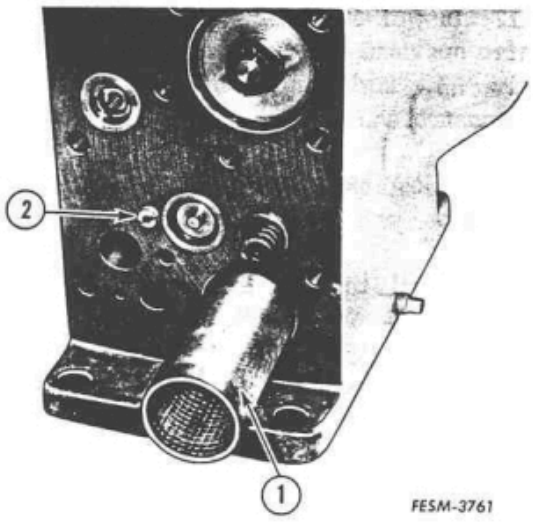
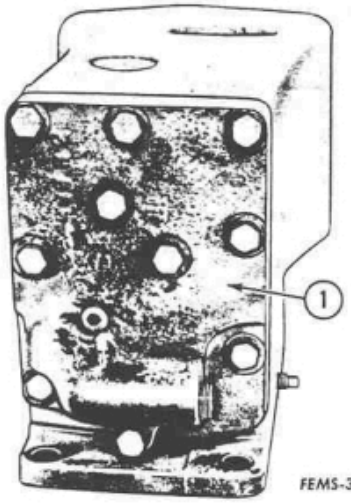
1. Piston
2. Connecting rod yoke
3. Yoke nut



12. Install the cylinder block oil strainer (1).

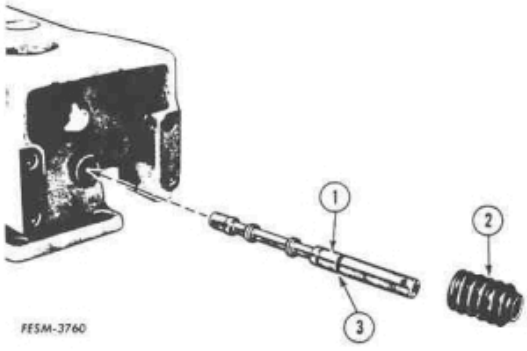
1. Oil strainer



13. Install the cylinder head (1) and new gasket. Tighten the cap screws evenly and in steps to 45 ft. lbs. torque.

IMPORTANT: Never install the control valve from the cylinder head end of the block. Always install the cylinder head before installing the control valve. This prevents damage to the seal ring.

1. Cylinder head

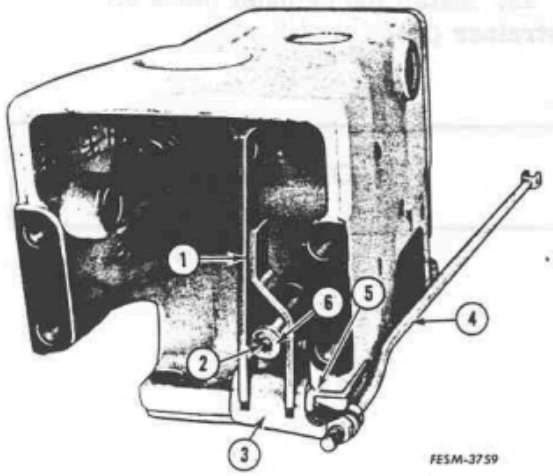


14. Install the control valve (1) and boot (2) in the block being sure to use a new O-ring (3).

15. Install the cylinder block cover with a new gasket. Tighten the cap screws to 35 ft. lbs. torque.

16. Install the pipe plugs in the block.

1. Control valve 2. Boot 3. O-ring



17. Install the lever pin in the control valve operating lever (1) and the control valve (6). Tighten the set screw (2) in the control valve.

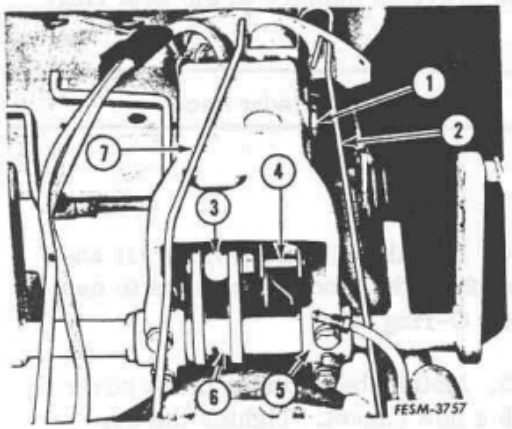
18. Install the control rod (4) and the adjustable yoke (3).

19. Install the operating lever stop (5) and lock. Do not tighten the cap screws at this time.

20. Install the control valve operating link on the operating lever.

1. Control valve operating lever
2. Set screw
3. Adjustable yoke
4. Control rod
5. Operating lever stop
6. Control valve

INSTALLATION



1. Filler plug
2. Choke control rod
3. Connecting rod
4. Connecting rod pin
5. Rockshaft bearing
6. Rockshaft
7. Throttle to governor rod

1. Install the pump on the engine using a new gasket. Tighten the cap screws to 20 ft. lbs. torque.

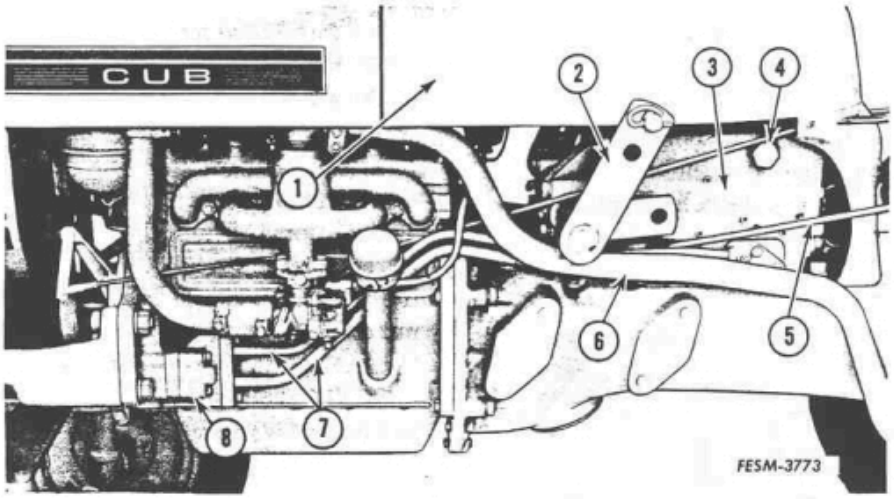
2. Install the cylinder block on the tractor and tighten the cap screws to 80 ft. lbs. torque.

3. Install the rockshaft (6) and rockshaft bearings (5). Tighten the cap screws to 80 ft. lbs. torque.

4. Install the connecting rod pin (4) in the connecting rod (3), rockshaft (6) and control valve link.

5. Install the choke control rod (2).

6. Install the governor control rod (7).



1. Hood and fuel tank
2. Rockshaft
3. Cylinder block
4. Filler plug
5. Control rod
6. Exhaust pipe
7. Manifold tubes
8. Touch-control pump

7. Using a new gasket and O-rings, install and connect the manifold tubes (7) to the cylinder block (3) and the pump (8).

8. Connect the control rod (5) to the hand control lever.

9. Install the helper spring and rod and the lift link on the rockshaft.

10. Install the exhaust pipe (6).

11. Install the hood and fuel tank (1) and connect the fuel line to the fuel strainer.

12. Install the headlights and connect the wires.

13. Fill the cylinder block with 4-1/4 pints of Hy-Tran fluid. It will be necessary to free the system of trapped air as follows:

(a) With the filler plug (4) removed, start the engine and operate it at a moderate idle speed.

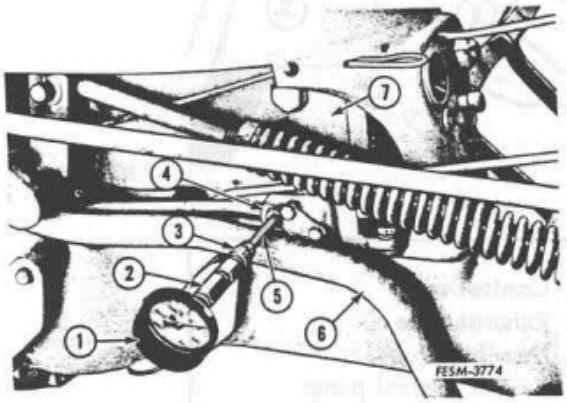
(b) Move the Touch-Control lever back and forth 10 or 12 times through its full range of travel. This quickly frees the system of trapped air.

(c) With the control lever in the rearward position, stop the engine. If necessary, add sufficient clean fluid to the reservoir to bring the fluid level to within 1/2-inch of the bottom of the filler opening.

(d) Install the filler plug and tighten securely.

14. Adjust the control valve operating lever stop as follows:

(a) Install the pressure gauge, FES 1-2 (1) and pressure snubber, FES 94-6 (2), in the 1/8-inch pipe plug hole of the rear manifold flange (4).



1. Hydraulic gauge, FES 1-2
2. Pressure snubber, FES 94-6
3. 1/4" - 1/8" reducer pipe coupler
4. Hydraulic manifold rear flange
5. 1/8" pipe nipple
6. Exhaust pipe
7. Cylinder block

(b) Loosen the cap screws slightly so that the stop moves freely forward and back in its slotted holes.

(c) With the engine operating at half to full governed speed, move the Touch-Control hand lever forward until, at the forward end of the rockshaft stroke, the pressure gauge registers high pressure.

NOTE: Should the hand lever come to the end of its travel before high pressure is indicated, shorten the control rod at the adjustable yoke.

(d) Watching the pressure gauge, move the Touch-Control hand lever to the rear far enough to return the system to low pressure but not far enough to move the rockshaft from its extreme position.

(e) With the rockshaft in the extreme forward position, establish that position by measuring the distance between the pin in the rockshaft arm and the carburetor bowl cover. Keep the figure in mind.

(f) Then with your rule in the same position, touch the hand lever and move the rockshaft rearward 3/8-inch. Holding the stop forward against the operating lever pin, tighten the cap screws.

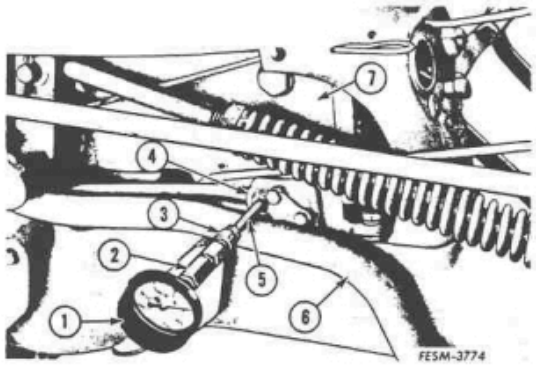
(g) Operate the hand lever back and forth a number of times and check to see that the 3/8-inch differential is maintained.

NOTE: If necessary, readjust the stop until the 3/8-inch measurement is correct, then lock the stop cap screws by bending the lock strip.

TROUBLE SHOOTING TEST PROCEDURE

General

In all trouble shooting tests of the Touch-Control system it is necessary to ascertain the pressure in the pump manifold. For this, the use of hydraulic gauge, FES 1-2 (1), and pressure snubber, FES 94-6 (2), is recommended. They should be installed in place of the upper pipe plug (1/8 inch) in the hydraulic manifold rear flange (4). A 1/4" - 1/8" reducer pipe coupling (3) and a 1/8" pipe nipple (5), long enough to clear the exhaust pipe (6), will be needed to install the hydraulic gauge and snubber in the 1/8-inch pipe plug hole.

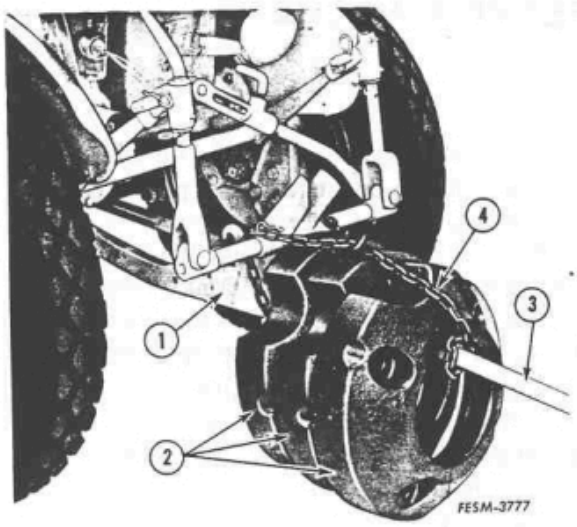


1. Hydraulic gauge, FES 1-2
2. Pressure snubber, FES 94-6
3. 1/4" - 1/8" reducer pipe coupling
4. Hydraulic manifold rear flange
5. 1/8" pipe nipple
6. Exhaust pipe
7. Cylinder block

In checking pressure, it should be understood that high pressure in the pump manifold is normal only during movement of the rockshaft and that the pressure varies with the load. (Maximum pressure at high idle will not exceed 1100-1500 pounds per square inch, because at some point in that pressure range the safety valve will open.) When the rockshaft movement is completed normal low pressure is restored. Normal low pressure is governed by the pressure regulator valve, and low pressures are not a factor in the trouble-shooting test procedure.

If and when improper adjustment, overload, or faulty operation of the pressure regulator valve causes the pressure to remain high, the temperature of the oil rises rapidly. Continued operation with unrelieved high pressure and high temperature causes failure of gaskets and seals in the block and the pump. Abnormally high pressure in the system is indicated by continued laboring of the tractor engine, a higher sound level in the pump, and a steady rise in the temperature of the hydraulic fluid.

To analyze a failure of the Touch-Control system, tests must be made before the units are removed from the tractor and a load must be provided which will approximate the weight of an implement.



Insert a large pry bar (3) in the fast hitch pull bar (1). Install a weight of approximately 300 pounds (2) on the bar and secure with a chain (4). This weight on the rear is equal to about one-half of the total permissible load for the lift.

1. Pull bar
2. Weights (300 pounds)
3. Pry bar
4. Chain

Procedure

The test procedure given here should be followed in its entirety in all cases when checking a failed Touch-Control system. The step-by-step procedure is designed to uncover the source or sources of the trouble in a logical, orderly way, eliminating guesswork and leaving no doubt of the final outcome. The test procedure discloses certain irregular "conditions" which have developed as the result of wear, maladjustment, breakage, etc. These "conditions" are listed in the Trouble Shooting Chart which follows, together with "causes" and "remedies." Once the irregular "condition" or "conditions" are established, reference to the Trouble Shooting Chart indicates the procedure to be followed from then on.

NOTE: Complete all ten steps of the test procedure in every case. Do not be satisfied if one of the intermediate steps discloses an irregular "condition." There may be more. Continue testing to the end. Only then can you be sure you have located all the trouble.

The step-by-step test procedure follows. Do not change the order.

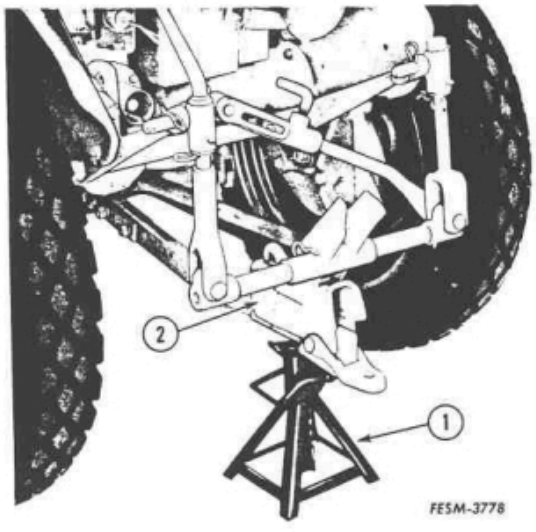
Step 1. Apply test load as previously outlined. Install hydraulic gauge, FES 1-2, and pressure snubber, FES 94-6, in the hydraulic manifold rear flange.

Step 2. Remove all dirt from the reservoir filler plug. Remove the filler plug, check the Touch-Control fluid level, and, if necessary, add fluid as instructed in the owner's manual. If more than a quart is required to bring the fluid up to the proper level, that may be evidence of leakage from the hydraulic pump into the engine crankcase. Note, for future reference, the level of the oil in the engine crankcase.

Step 3. Clean thoroughly all external surfaces of the hydraulic block, manifold, and pump, and examine these surfaces for evidence of fluid leakage during and after performance of Step 4.

Step 4. Start the tractor engine and move the Touch-Control hand levers back and forth several times to eliminate air from the system. Note the speed of the rockshaft with the engine running at (a) half throttle and (b) high idle speed in order to determine the efficiency of the system. At high idle speed the rockshaft should complete its stroke in the lifting direction in approximately 1 to 2 seconds. If the time required to make a complete movement in the lifting direction exceeds the normal, see Condition 2A in the Trouble Shooting Chart.

If the rockshaft arms do not move, note the pressure reading on the hydraulic gauge. If the pressure is high, refer to the Trouble Shooting Chart, Condition 1. If there is little or no pressure, refer to Condition 2. Either of these irregular conditions must be corrected before you can proceed with Step 5.



Step 5. With the engine running, place the hand levers at the following locations for 10 seconds.

(a) At each of the extreme end positions on the operating lever quadrant. If the pressure in the system remains high only at the end of the rockshaft stroke, see Condition 3 in the Chart.

(b) At any intermediate position on the operating lever quadrant. If the pressure remains high, see Condition 4.

Step 6. With the tractor engine running, place the hand levers in a central position on the operating lever quadrant. Then, after the rockshaft arm has come to rest, pencil-mark the position of the rockshaft on the fuel tank. Observe, for a period of two minutes, whether there is any movement from the marked position. Then stop the tractor engine and, after an interval of five minutes, check to determine whether there has been any movement. If movement is observed in either case, see the Trouble Shooting Chart, Condition 5.

Step 7. Remove the weights and the pry bar. Place a jack stand (1) or block under the pull bar (2) and attempt to raise the rear of the tractor by applying down pressure on the hitch. If the pressure in the system exceeds 1500 psi, see Condition 9 in the Chart.

Pencil mark the position of the rockshaft arm on the fuel tank. Stop the engine and, after an interval of five minutes, check to determine whether there has been any movement. If movement is observed, see Condition 6.

1. Stand
2. Pull bar

Step 8. Start the tractor engine. Operate the hand levers and note whether they show any tendency to creep in the direction of the rockshaft movement. If they do, see Condition 8 in the Chart.

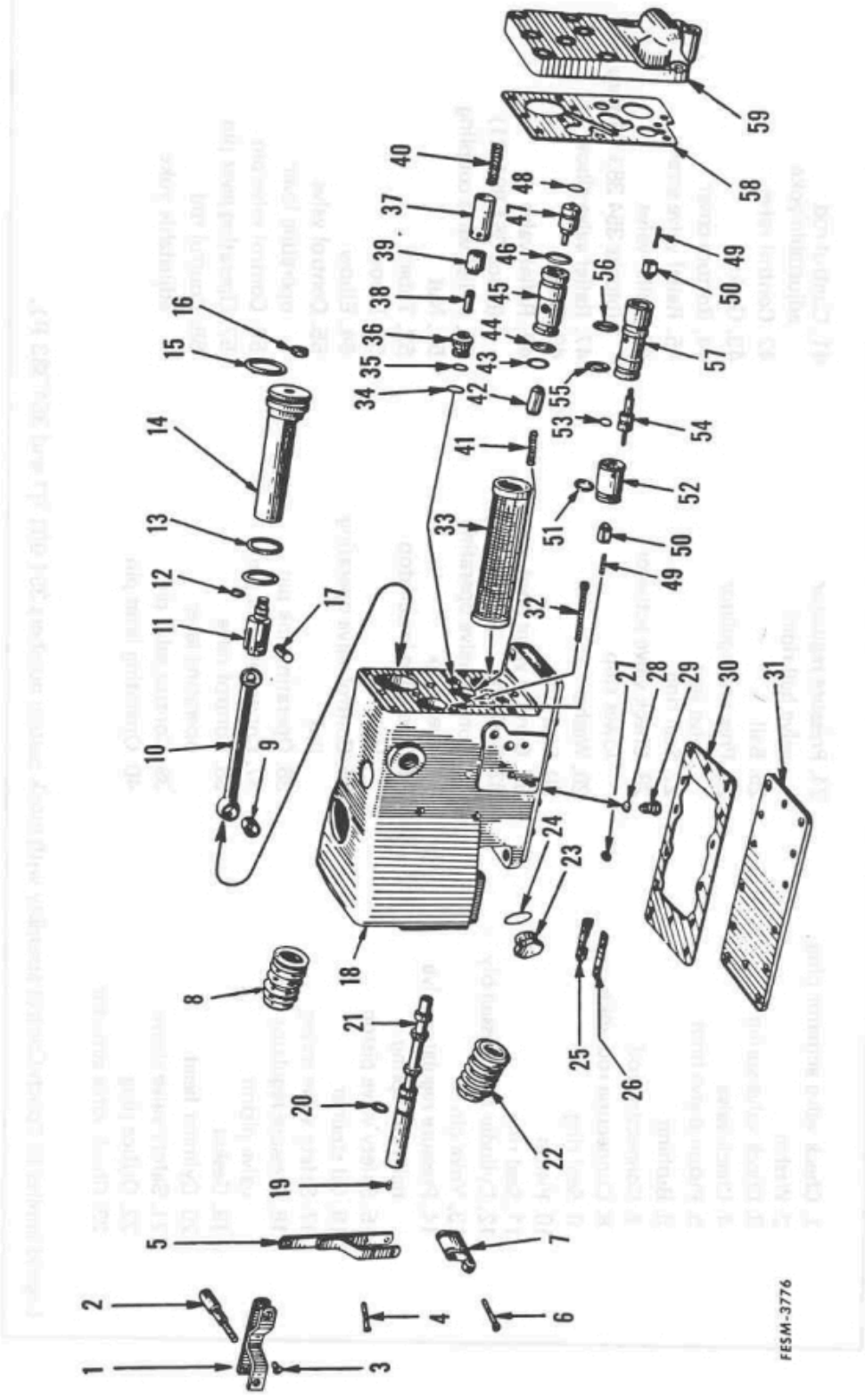
Step 9. Stop the tractor engine and inspect the Touch-Control unit, manifold, and pump for evidence of external leakage. If leakage is noted, see Condition 10 in the Chart.

Step 10. With the piston in the retracted position, check the Touch-Control fluid level in the hydraulic reservoir to make sure there has been no loss. If oil has been lost, check the engine crankcase oil level and refer to Condition 7 in the Trouble Shooting Chart.

With completion of Step 10 you have performed all the tests ordinarily necessary to disclose the source of any trouble in the Touch-Control system. Further procedure was indicated by the Trouble Shooting Chart references.

1. Check valve actuator plug
2. Washer
3. Check valve spring
4. Check valve
5. Piston sleeve boot
6. Bushing
7. Connecting rod
8. Connecting rod yoke
9. Seal ring
10. Piston
11. Seal ring
12. Cylinder block assembly
13. Yoke pin
14. Pressure regulator valve ball rider spring
15. Safety valve piston
16. Oil strainer
17. Safety valve spring
18. Pressure regulator valve piston
19. Gasket
20. Cylinder head
21. Safety valve sleeve
22. Orifice plug
23. Check valve actuator
24. Pressure regulator valve ball rider
25. Ball
26. Pressure regulator valve seat
27. Seal ring
28. Check valve actuator lower stop
29. Washer
30. Seal ring
31. Control valve boot
32. Seal ring
33. Control valve operating lever stop
34. Operating lower stop lock
35. Control valve operating link
36. Operating link pin
37. Connecting rod pin
38. Control valve operating lever
39. Control valve pin
40. Operating lever pin
41. Control rod adjustable yoke
42. Control valve
43. Gasket
44. Bottom cover
45. Relief valve screen
46. Relief valve (blocks 354 383 R1 thru R4)
47. Relief valve elbow
48. Screw
49. Relief valve (block 351 981 R1)
50. Relief valve coupling
51. Nut
52. Tube
53. Elbow
54. Elbow
55. Control valve operating lever
56. Control valve pin
57. Operating lever pin
58. Control rod adjustable yoke

Legend applies to Touch-Control assembly with block casting numbers 351 981 R1 and 354 383 R1.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1. Control valve operating link
2. Connecting rod pin
3. Control valve operating link pin
4. Control valve pin
5. Control valve operating lever
6. Control valve operating lever pin
7. Control rod adjustable yoke
8. Piston sleeve boot
9. Connecting rod bushing
10. Connecting rod
11. Connecting rod yoke
12. Connecting rod yoke seal ring
13. Piston sleeve seal rings
14. Piston
15. Piston head seal ring
16. Connecting rod yoke nut
17. Connecting rod yoke pin
18. Cylinder block assembly
19. Set screw
20. Control valve seal ring
21. Control valve
22. Control valve boot
23. Filler plug
24. Filler plug gasket
25. Control valve operating lever stop
26. Control valve operating lever stop lock
27. Pipe plug
28. Relief valve screen
29. Relief valve
30. Cylinder block cover gasket
31. Cylinder block cover
32. Orifice plug w/screen
33. Cylinder block oil strainer
34. Safety valve bushing tension spring
35. Safety valve inner bushing seal ring
36. Safety valve inner bushing
37. Safety valve outer bushing
38. Safety valve piston
39. Safety valve sleeve
40. Safety valve spring
41. Pressure regulator check valve spring
42. Pressure regulator check valve
43. Pressure regulator valve tension spring
44. Pressure regulator valve bushing front seal ring
45. Pressure regulator valve bushing
46. Pressure regulator valve bushing rear seal ring
47. Pressure regulator valve piston
48. Pressure regulator valve piston seal ring
49. Check valve spring
50. Check valve
51. Check valve bushing inner seal ring
52. Check valve inner bushing
53. Check valve actuator seal ring
54. Check actuator valve
55. Check valve bushing outer seal ring (small)
56. Check valve bushing outer seal ring (large)
57. Check valve outer bushing
58. Cylinder head gasket
59. Cylinder head

Legend applies to Touch-Control assembly with cylinder block casting number 360 719 R1.

TROUBLE SHOOTING CHART

NOTE: Reference numbers throughout the Chart identify parts in Illust. on page 8-32.

Condition	Possible Causes	Remedies
1. System is unable to lift load. Gauge shows high pressure.	1. System is overloaded.	1. Reduce load to normal (total permissible load as described on page 8-28).
	2. Rockshaft bearings are scored. Rockshaft seized in bearings.	2. Replace rockshaft bearings and lubricate. Check for free operation by testing end play of shaft or shafts.
	3. Damage to implement, restricting freedom of movement.	3. Inspect implement for seized bearings or other damage restricting movement. Disconnect implement and observe operation of hydraulic system without load.
	4. Defective valve block head gasket.	4. Replace gasket.

Condition	Possible Causes	Remedies
2. System is unable to lift load. Gauge shows little or no pressure.	1. No fluid in system (and no evidence of external leakage).	1. Check engine oil level and compare with level previously noted in Step 2 of Test Procedure. An increase in engine oil level indicates leakage from the hydraulic pump. Refer to Condition 7 in the Chart.
	2. Failure of hydraulic pump to produce pressure.	2. Inspect pump O-rings and seal for damage. Replace pump if it is worn or damaged.
	3. Failure of regulator valve.	3. Check regulator valve piston (47) for free movement in block. Inspect condition of seal ring (48) as possible cause of stuck piston. Inspect bushing (45) and check valve (42) for wear or accumulation of foreign matter. Inspect for broken spring (41).
	4. Safety valve stuck open. Safety valve spring broken.	4. Inspect safety valve spring (40), check its tension, and replace it if broken or below tension specification (free length: 1-15/16 inches; requires 61-67 pounds to compress it to 1-1/4 inches). Check safety valve piston (38) for free movement in the block.
2A. System lifts load but very slowly. Gauge shows reduced pressure.	1. Same as 2, 3, and 4 under Condition 2.	1. Same as 2, 3, and 4 under Condition 2.
	2. Opening in orifice plug (32) has been enlarged beyond proper size of .024 inch.	2. Replace the orifice plug (32).
	3. Pipe plugs within the block are loose or out of place.	3. Replace plugs.

Condition	Possible Causes	Remedies
3. Gauge shows (a) high pressure when the hand levers are stopped at either of the extreme end positions on the operating lever quadrant.	1. Interference between the mounted machine and the tractor, preventing the rockshaft from traveling the full distance it is set for.	1. Refer to the Operator's Manual instructions covering adjustment of operator's control lever stops on the quadrant.
	2. Adjustable stop (25), which limits the movement of the control spool valve, is not properly adjusted.	2. Readjust stop (25), using test gauge in hydraulic manifold. (Refer to page 8-26.
4. Gauge shows high pressure with hand levers and rockshaft in any position, end or intermediate.	1. The orifice plug (32) is stopped up with foreign matter, making regulator valve inoperative.	1. Remove the plug in the head which allows access to the orifice plug (32). Remove and clean the orifice being sure not to enlarge orifice above maximum specifications. Before replacing the orifice plug, flush out the opening by cranking the engine with the ignition turned off.
	2. The regulator valve piston (47) and its seal ring (48) are stuck in the block bore, making the regulator valve inoperative.	2. Remove the regulator piston (47) and seal ring (48). Free up the piston and replace it, together with a new seal ring.
	3. Loose or missing plugs in the lift reservoir.	3. Tighten the pipe plugs or install new ones.
	4. Cracked or porous case.	4. Inspect the piston bores and the case for cracks and porosity. If necessary, replace the case.

Condition	Possible Causes	Remedies
5. While the engine is running, the load on the rockshaft oscillates about 3/4 inch (hiccuping). When the engine is stopped, the load lowers slowly to the ground. When the engine is restarted, the rockshaft raises the load back to the position for which the operator's lever is set.	1. Oil has leaked out on the rear, or raising, side of the piston. Leakage may occur for one or more of the following reasons:	1. Stop leakage by action as follows:
	(a) Failure of check valves (50) to seat in their bushings, because of poor seating surface on valve or seat.	(a) Inspect check valves (50) and their seats in the bushings for nicks, burrs, and foreign matter which would prevent proper seating of the valves. Replace as necessary. Test the check valve springs (49) for length and condition. (Refer to "Specifications".)
	(b) Defective seal rings (51, 55 and 56) on the check valve bushings (52 and 57).	(b) Inspect seal rings (51, 55 and 56) for leakage and, in any case, replace them. Be sure the correct seal rings are used on the bushings (52 and 57).
	(c) Defective seal ring (15) on piston (14).	(c) Inspect and renew seal ring (15) on piston (14).
	(d) Defective head gasket (58).	(d) Inspect head gasket (58) for possible leakage. Clean head and block gasket surfaces and install new gasket when reassembling.
	(e) Hole in cylinder bores of block or cylinder head.	(e) Look for faults in cylinder bore in block casting. Examine cylinder head for cracks, sandholes, and defective gasket. Replace if necessary.

Condition	Possible Causes	Remedies
6. Down pressure on the implement cannot be maintained, but the implement may be held in the raised position without difficulty.	1. Same as (a), (b) and (c) under Condition 5. 2. Hole in cylinder bores of block. 3. Piston sleeve inner seal ring (13) is leaking. 4. Leakage at the weld between the piston head and sleeve. 5. Leakage from the relief valve (29).	1. Same as (a), (b) and (c) under Condition 5. 2. Examine cylinder bores. If necessary, replace block. 3. Inspect inner seal ring (13) on piston sleeve. Install new rings. 4. Remove piston. Fill piston sleeve with cleaning solvent and check the weld for leakage. If piston is defective, replace it. 5. Remove the relief valve (29). Test for leakage by trying to blow through the valve. Replace if there is any leakage.
7. There is loss of oil from the hydraulic system with no evidence of external leakage.	1. Oil is leaking from the hydraulic pump into the engine crankcase.	1. Replace the seal on the hydraulic pump drive. It is recommended that all seal rings be replaced at each overhaul. Before installing new seal rings, examine them for evidence of deterioration or damage caused by improper handling or storing. Surface checks or nicks in these synthetic rubber rings make them unfit for use. When filling the block reservoir, follow instructions in the Operator's Manual in order to avoid overfilling.
8. The hand levers creep while the rockshaft is in motion.	1. Insufficient friction on the hand control lever.	1. Disconnect the control rods and attach a spring scale at the "neck" of the hand lever. Pressure required to move the lever should not be less than 1-1/2 pounds or more than 3 pounds. If the friction does not come within that range, replace friction disk and spring. Readjust friction.

Condition	Possible Causes	Remedies
8. The hand levers creep while the rockshaft is in motion. (Cont'd)	2. The control rod which connects with the operator's lever is sprung, causing tightness in the pivot of the control rod adjustable yoke (7).	2. Free up the adjustable yoke (7).
	3. Free movement of the control spool valve is being interfered with by (a) misalignment, (b) friction between the control valve pin (4) and the casting, and (c) distortion of the control valve operating lever (5).	3. Check the control valve operating lever (5) for free movement and free up if necessary.
	4. Dirt, burrs, or scored bores in the block are preventing the control spool valve from moving freely.	4. Clean the control spool valve (21) and bore. Remove burrs.
9. Operating pressure exceeds permissible maximum of 1500 pounds per square inch.	1. Safety valve piston (38) is fitted too close in its bore, or burrs and dirt are causing it to stick closed.	1. Clean safety valve piston and bore, remove burrs, free up.
	2. Wrong safety valve spring (40) was installed.	2. Inspect safety valve spring (40). Replace if broken or if tension is below specifications (free length 1-15/16 inch and should compress to 1-1/4 inch under 61 to 67 pounds pressure).
10. External leakage.	1. Welsh plugs leaking.	1. After checking for cracks in the cylinder block in this region, put in a new welsh plug with sealer.

Condition	Possible Causes	Remedies
10. External leakage. (Cont'd)	2. Pipe plugs leaking.	2. Check the threads on the pipe plugs and in the cylinder block. If in good condition, add a light coat of sealer and tighten the plugs.
	3. Oil leaking into piston rod boot as the result of:	3. Stop leakage by action as follows:
	(a) Damaged piston sleeve outer seal ring (13).	(a) Replace the damaged seal ring (13).
	(b) Loose connecting rod yoke nut (16). Rough connecting rod yoke seating surface.	(b) Tighten connecting rod yoke nut (16) to 75 ft. lbs. torque. Smooth the connecting rod yoke seating surface. Replace seal ring on yoke.
	(c) Break in weld between the piston head and sleeve.	(c) Replace piston assembly.
	4. Oil leaking into the control valve boot.	4. Inspect the control valve bore for scratches. Inspect the condition of the control valve seal ring. In any case, replace the seal ring.
	5. Oil leaking from behind the Touch-Control cylinder head or the rear manifold flange.	5. Check tightness of the capscrews. If gaskets are defective, replace them. Make sure the Touch-Control heads are flat and that there are no blow holes in the casting.
	6. Oil leaking at the manifold front flange.	6. Check the depth of the front flange seal ring grooves. Seal rings should extend slightly above the surface of the flange. Look for cuts and wear in the seal rings. Inspect the manifold front flange and the pump flange. Both flanges should have a smooth, flat surface. When reassembling, renew all seal rings.

Section 9

ELECTRICAL

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Complete Overhaul and Testing information is covered in GSS-1052-C.

SPECIFICATIONS

Timing

Ignition timing (Before TDC)
- High idle ± 1 degree . . . . . 16°
- At 375 rpm (See Note) . . . . . 0°

NOTE: Proper ignition timing at high idle is essential for best performance and engine life. Therefore, the distributor should be set to give the exact timing at high idle. Any variance that may exist then will occur at the low idle end of the advance curve.

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Distributor

MODEL TYPE AND NUMBER	SYMBOL OR CODE	ROTATION VIEWING DRIVE END	GOVERNOR SPRING PACKAGE	DEGREES OF AUTOMATIC SPARK ADVANCE AT VARIOUS ENGINE RPM'S			
				400	800	1200	1600
IH 353 893 R91	D	CCW	358 107 R91	0–1	4–8	10–14	15–16
Prestolite 107 573 C91	–	CCW	531 458 R1	0–1	4–8	10–14	15–16

Dwell Angle

66° – 72° AT ANY R.P.M.

Magneto

MODEL	ROTATION VIEWING DRIVE END	BREAKER POINT GAP	IMPULSE COUPLING TRIP POINT	SPARK ADVANCE
IH, J4	CCW	.013 inch	T.D.C.	13 degrees

Alternator

DELCO-REMY NUMBER	GROUND	ROTATION VIEWING DRIVE END	FIELD – CURRENT 80° F		COLD – OUTPUT		RATED HOT OUTPUT AMPS
			AMPS	VOLTS	AMPS	APPROX. R.P.M.	
1100578	N	CW	4.0 – 4.5	12	22 33	2000 5000	37

Generators

Delco-Remy Number	Rotation Viewing Drive End	Circuit	Brush Spring Tension (Oz)	Field Current At 80° F		Cold Output ①			Hot Output ②		
				Amps	Volts	Amps	Volts	Approx RPM	Amps	Volts	Approx RPM
1 100 501	C	A	24	2.50-2.72	6	20-25	7	2400	16-19	6.9-7.1	2500
1 100 531	C	A	16	2.50-2.72	6	20-25	7	2400	16-19	6.9-7.1	2500
1 101 355	C	A	16	3.5-4.5	6	13-16	7.7-8.1	1800	9-11	7.3-7.6	1900
1 101 423	C	A	16	2.50-2.72	6	12-15	7.7-8.0	2000	9-11	7.3-7.6	2200
1 100 055	C	A	28	1.85-2.03	6	35	8.0	2950	—	—	—
1 100 401	C	A	28	1.58-1.67	12	25	14	3040	—	—	—

① Cold output specifications apply to generators at 80 degree F. with brushes well seated.

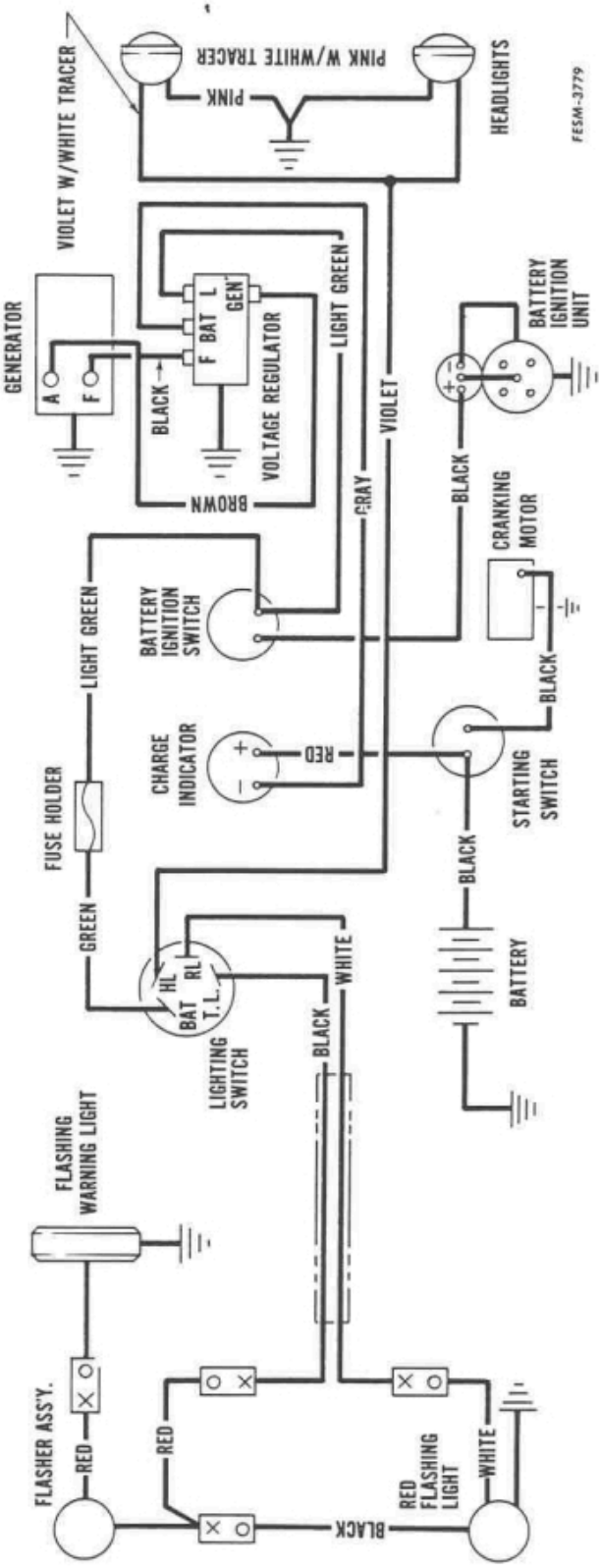
② Hot output specifications apply to generators at operating temperature which should be used when checking third brush generators.

Voltage Regulators

Delco-Remy Model Number ①	Circuit	Polarity, Battery Ground	Cut Out Relay			Voltage Regulator		Current Regulator	
			Air Gap (in.)	Point Opening (in.)	Closing Voltage	Air Gap (in.)	Voltage Setting	Air Gap (in.)	Current Setting
1 118 308	A	P	.020	.020	5.9-7.0	.075	6.6-7.2	—	—
1 118 982	A	P	.020	.020	5.9-7.0	.075	6.6-7.2	—	—
1 119 575	A	P	.020	.020	5.9-7.0	.075	6.6-7.2	—	—
1 118 999	A	N	.020	.020	11.8-14.0	.075	13.6-14.5	—	—

① When the number is followed by an alphabetical letter the specifications are the same as for the basic number except regulators with an "E" suffix have an air gap of .060" instead of .075" on the voltage unit.

Cranking Motor

Delco-Remy Model Number	Rotation Viewing Drive End	Brush Tension Min. (oz.)	No Load Test		
			Amps-Max.	Volts	Rpm
1 107 327	C	35	80	9	5500
1 109 603	C	24-28	60	5.7	5000
1 109 611	C	24-28	60	5.7	5000

WIRING DIAGRAM